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CIVIL ENGINEERING.

Extracts from the Report of NAPOLEON GARELLA, *an Engineer appointed by the French Government to survey the Isthmus of Panama. Translated for the Journal of the Franklin Institute by* PERSIFOR FRAZER, ESQ.

(Continued from page 154.)

Estimate of the Expenses of Constructing the Canal.

I will not enter here into the details of the calculations which have served me in estimating approximatively the cost of construction of the canal which I propose. It will be sufficient to make known their results, as well as the principal bases on which they are founded.

Of these, the price of labor is undoubtedly the most essential, and at the same time the most difficult to estimate exactly; in the isthmus, where there are no public works, we meet with nothing from which to draw a comparison, unless it is the wages of a few masons and carpenters, who, on account of their limited number and the scarcity of work, are paid at a very high rate. We must not expect, therefore, to find in the country any of the artisans, such as masons, carpenters, smiths, &c., that will be required in the execution of the work; neither will we find laborers accustomed to the handling of tools, but, as for this the apprenticeship will be neither long nor difficult, we may count on the country and the adjoining ones to furnish the necessary force, which may be readily instructed in their work. The workmen whom I have had occasion to employ in my explora-

tions in the isthmus, to open paths, and to clear the line followed by the levelings, were paid from 2½ to 3 reals per day, besides their nourishment, which amounted to ½ or ¾ of a real more. 4 reals (2 francs 50 cen.) will then represent the maximum of their wages. In my estimates I have taken this base as the minimum of the wages of a laborer, and have put at 3 francs that of the workmen to be employed in excavating, &c., whom it will be necessary to instruct in their work. This, however, is the only element I have drawn from the ordinary prices of the country: the other wages I have based upon similar ones in France, augmenting them 50 per cent.,—thus I have raised those of carpenters and stone cutters to 7f. 50 cent. a day; those of masons, quarrymen, smiths, &c. to 5 francs, and so for the rest.

Starting from these bases, I have arrived at the following estimates:

Art 1.—*Excavations, Embankments, &c.*

1st. Summit Level—Length 7730 metres.

	Metres.	Cubic met.		Fr's. cent.	Fr's. cent.	Francs cent.
Tunnel, length,	5350		at	6,700·00		35,845,000·00
South deep cut,	1570	816,729,600 in rock,	"	7·62	6,223,479·55	10,307,114·33
North " "	810	543,759,625 "	"	7·51	4,083,634·78	
Total,	7730					46,152,114·33

2nd. Pacific Slope—Length 13,450 metres.

	Cubic metres.		Fr's. ct.	Fr's. ct.	Fr's. ct.
Excavations,	1,928,413,851	in earth,	at 1·16 av. price,		2,244,749·96
Embankments,	711,298,800	from cuttings,	" 0·25	177,824·70	
	1,485,721,500	fm. side cuttings	" 1·38	2,047,535·68	
				2,225,360·38	
					4,470,110·34

3d. Atlantic Slope—Length 33,650 metres.

	Cubic metres.		Fr's. ct.	Fr's. ct.	Fr's. ct.
Excavations,	350,000,000	in rock,	at 7·58	2,653,000·00	
	5,736,538,606	in earth,	" 1·22	7,437,980·10	
				10,090,980·10	
Embankments,	4,502,632,113	fm. cuttings,	at 0·25	1,125,658·03	
	678,991,575	fm. side do.	" 1·38	937,008·37	
				2,062,666·40	
					12,153,646·40
Total for the Canal between the Pacific and the Rio Chagres at Dos Hermanos,					62,775,871·17

4th. Canal from the Bay of Limon to Rio Chagres.

	Cub. met.		Fr's ct..	Fr's. cent.	
Excavations in earth,	6,693,907,500	at	1·94	12,986,180·55	
	698,002,500	"	1·19	830,664·87	
Dredging,	240,831,670	"	3·63	874,218·96	
					14,691,034·38

5th. Rectification of the Rio Chagres.

Excavation of canal for a length of 4,140 metres, at a mean depth of 10 metres—section of 385·20 sq. metres.

	Cub. met.		Fr's. ct.	Fr's. cent.	
Excavation,	1,594,728	at	1·15	1,834,537·20	
Deepening the bed of the river for a length of 5170 metres, 90 metres cube per metre to be raised by steam dredging.					
	Cub. met.		Fr's.	Fr's. cent.	
Dredging,	465,300	at	2	930,600·00	
Tow path,	5,170	"	20 per metre,	103,400·00	
			Total		2,868,537·20
Amount carried forward,					80,335,442·75

Amount brought forward,	80,335,442·75

6th. Feeders—length 100,000 metres.

Estimated at 25 francs per metre, comprising draws, bridges &c.,	2,500,000·00
Total of excavations, embankments, &c.,	82,835,442·75

ART. II.—*Constructions.*

		Fr's. ct.	
36 locks	at 600,000 francs each,	21,600,000·00	
3 large aqueducts,	" 265,000 francs,	795,000·00	
3 small "	" 75,000 francs,	225,000·00	
			22,620,000·00

ART. III.—*Ports at the extremities of the Canal.*

1st. Port of Limon on the Atlantic.

	Fr's. ct.
Mole of 1000 metres in length; mean depth of water 6 metres; mean section 456·70 cubic metres.	4,085,050·00
Dredging over a surface of 1,000,000 square metres to a mean depth of 2·50 metres—2,500,000 cubic metres at 2 francs,	5,000,000·00
Total,	9,085,050·00

2nd. Port of Vaca di Monte on the Pacific.

Two jettys 600 metres each in length; mean depth of water 6 metres, mean section 432·75 square metres,	4,525,894·40	
Dredging over a surface of 280,000 square metres; mean depth 3 metres—840,000 cubic metres at 2 francs,	1,680,000·00	
Total,	6,205,894·40	
Total for both ports,		15,290,944·40
For roads, houses of employees, &c.,		3,253,611·85
Grand total,		125,000,000·00

In this estimate, which amounts to 125 millions of francs, (under 25 millions of dollars,) I have not included the arching (revêtement) of the tunnel, which the consistent and compact nature of the rock through which it is to be cut will probably render unnecessary. Should it be otherwise, its execution would increase considerably the sum of the expenses. The arch, in brick, 1 metre thick, would cost, at the prices laid down for the rest of the work, 2600 francs per metre in length—which would be, for the whole, 13,910,000 francs, and would elevate the whole cost to 139 millions. But I repeat that I do not think it will be necessary, or if so, only to a small extent. For this reason I have not taken it into the estimate. At all events, to cover all possible chances, it will be sufficient to increase the estimate by 5 millions, making the probable expense 130 millions of francs.

This valuation is on the supposition that the summit-level is to be established by means of a tunnel. In the case of a deep cut whose bed would be 15 metres higher than that of the tunnel, the expense would be considerably greater, both on account of the increased number of locks and the cube of excavation. In making the summit-level, by means of a deep cut of 84 metres in maximum depth, the additional expense would be about 19 millions, and, consequently, the whole expense 149 millions of francs.

We may see by this, that the project with a tunnel offers, over that with a deep cut, beside the advantages of a more easy and certain supply of water and a shorter navigation, that very important one of

a considerable diminution of expense. It would not be impossible, in raising the summit-level, to diminish the cost; but the economy would be at the sacrifice of the excellence of the line, and the advantages to be obtained from the canal.

The object of the mission with which I was charged, was to ascertain the possibility of the construction of a canal across the isthmus, and to arrive at an approximative estimate of the cost of such a work. I have not, therefore, the pretension of offering a complete project, and still less of indicating the best line to follow. A more profound and detailed examination than that I was enabled to make during the short period I passed in the isthmus, might result in the discovery of more suitable points of passage of the chain, and thereby diminish the estimate of expense. My labor will not the less have fulfilled the object I had in view, which was to prove the possibility of the junction of the two oceans, and to fix a maximum evaluation of expenses, which may be diminished by the discovery of a better line.

Probable Revenue of the Canal.

The revenue of the canal will be derived principally from the tolls taken from vessels passing through it. It is, therefore, proper to inquire what are the vessels likely to take this route.

From the tables prepared by the Minister of Commerce, the number of vessels belonging to the four great maritime powers, France, England, Holland, and the United States, which doubled the two capes, Horn and Good Hope, in the year 1841, amounts to 2966, with an united tonnage of 1,203,762 (being a mean tonnage of 405 per ship.) Of this number, it is difficult to know exactly what ships went by Cape Horn, and which doubled the Cape of Good Hope. But in taking as a base the division of the countries, we may establish the distinction approximatively. Thus, in giving to Cape Horn all the countries situated to the eastward of the Dutch East Indies, Sumatra, and the Isles of Sunda, and to the Cape of Good Hope those which are between Sunda and the eastern Coast of Africa, we have,

For Cape Horn,	1567	ships of	636,462 tons.
For the Cape of Good Hope,	1399	"	567,300 "
Total,	2966		1,203,762

This estimate is purely conjectural, and appears, in the actual state of things, to accord too much to the navigation by Cape Horn. But we may suppose that, were the isthmus of Panama cut through, the division would be more exact, and that in that case all the ships going to the eastward of Sunda, and even those going to Batavia, would adopt the last route. Instead of diminishing the estimated number, I think there would be reason for augmenting it. The tables of the Minister of Commerce take no account of the vessels of Spain, Russia, Sardinia, &c., nor of the movement resulting from the relations of Europe and the United States with the western coast of America, which itself may be estimated at, at least, 60,000 tons. If, again, we

remark the steady increase shown in the movement of commerce for the three years, 1839–40–41, which we may reasonably suppose to have been continued up to the present moment, we can, without fear of error, put down the sum of 700,000 tons, as a probable basis, from which we may rationally calculate the revenues of the canal; this sum expressing the passage which we may look for in the actual state of commercial relations, and not that still more considerable on which we have a right to count for the future, when these relations shall have been augmented, by the opening of a new route which, by abridging distances, will render voyages easier and less dangerous.

There remains now to be determined the rate of tolls to be charged on vessels traversing the isthmus. At first sight it appears natural to take as a base for the tariff the tonnage of vessels, and to establish it proportional to the volume of their cargo; that is, what has hitherto been proposed by those who have paid attention to this question. The government of New Grenada, which accorded the privilege of cutting the isthmus to the Salomon Company, left to this last the power of fixing the toll, with the sole condition that it should be the same for all nations. For my part, whilst I agree that the amount of tonnage should serve as a base for the tariff, it appears to me that the expense occasioned by the passage of vessels may be divided into two portions, of which one, destined to cover the interest of the capital employed in the construction, should be borne by vessels in proportion to their size and the importance of the advantages they derive from the establishment of this new route, and, consequently, it should be in proportion to their tonnage; as for the other portion of the expense occasioned by the passage of the locks, which demands the same labor and the same consumption of water, whatever may be the size of the ship, it should be fixed, and the same for all vessels.

We may suppose that the opening of the isthmus will make a mean diminution of at least a month in the length of the voyage of ships which take this route; the economy resulting to the owners may then be approximately valued, for a ship of 300 tons, as follows:—

Wages of officers and crew, provisions, &c.,	3000	
Interest at 1½ per cent. on the value of the cargo, say 100,000 francs,	500*	
Interest at 1 per cent. on the value of the ship, say 90,000 francs,	900	
Total of monthly expenses,	4400	(5400)
Difference of insurance of 1 per cent. on the united value of cargo and ship,	1900	
Total,	6300	(7300)

In dividing equally this saving between the company and the ship, it would be 3,150 francs (3,650) that the ship must pay to the com-

* This should be 1,500; the error affects the whole calculation.

pany, or 10 francs (12·16) per ton. In admitting, to a certain extent the principles laid down above, of the division of the expense into two portions, I would propose to fix the tariff of tolls as follows:—

For vessels of 300 tons and upwards, 10 fr's. per ton.
" under 300 tons, a fixed toll of 1500 fr's., and 5 fr's. per ton.

It may be objected that this tariff will be more onerous on small vessels than on large ones, to this I would reply that it not only appears to me fixed on a more just principle, but that it is precisely small vessels which would not risk the long voyages across the two oceans, and would make, in preference, from the United States and the West Indies, voyages along the coast to Chili, Peru, western Mexico, and the Oregon Territory, and which, consequently, having a greater interest in the opening of the isthmus, can afford to pay a little dearer for the advantage of being able to follow this new route.

To resume, we may then admit a minimum gross revenue of 10 francs per ton, or 7 millions of francs for the 700,000 tons which would pass through the canal.

From this sum, we must deduct the expenses for repairs, and of the administration of the canal, which may be estimated at 6000 francs per kilometre, (about $1824 per mile,) in taking as a base the valuations admitted in France, to wit:—1100 francs per kilometre for repairs, and 1500 francs for expenses of administration, together 2600 francs. The annual expense of the 76,500 metres of the line of navigation would then be 459,000 francs, which I will call 500,000 ($94,000,) to cover any difference, the nett revenue would then be reduced to 6,500,000 francs, exactly 5 per cent. on the expense of construction as estimated at 130 millions, for the project with a tunnel at the summit-level. To this principal source of revenue may be added the sale or improvement of the immense extent of land which the government of Bogota conceded to the Salomon Company in granting them the privilege of the route across the isthmus. Although this concession has been annulled by a posterior decree, founded on the non-performance of the conditions imposed by the government and accepted by the Company, there is reason to hope, indeed it is certain, that the same, or even greater advantages would be accorded to a Company who would seriously offer themselves with sufficient guarantees for the construction of the canal of Panama. I have not, however, regarded these advantages, on which we may count as certain, except in not having allowed in the estimate any thing for the acquisition of land, which, for the most part will be accorded gratuitously by the State, and of which the small portion belonging to individual proprietors will have a value much inferior to those conceded to the Company off the line of the canal.

In the proposition for a tariff of tolls, I have left to the charge of the vessels themselves the expenses of traction. These expenses will be very inferior to the dues to the canal. In France they are estimated at a mean price of ·05 centimes the ton per kilometre, at a rate of from 80 to 100 metres per minute. In adopting this price, and it certainly would not be greater in the isthmus, where horses and mules

cost but little, and where forage is easily obtained and cheap, the towing a ton across the line would cost 3·825 francs, and a ship of 300 tons 1147·50 francs.

At the rate of 80 metres per minute, the whole line would be passed over in - -	16	hours.
To which must be added the time for passing the locks, 36 at 15 minutes each, - -	9	"
Total,	25	"

Or 2 days, supposing the service of the canal to be performed only by daylight.

Execution of the Work.

The three great maritime powers most interested in opening the route across the isthmus, are France, England, and the United States. A treaty passed between them guaranteeing the neutrality of the passage of the isthmus, will be sufficient to insure the free and quiet possession of the passage against the attacks of any other power, or even against one of the contracting parties themselves. The accession of the other powers interested, such as Holland, Spain, Russia, Sardinia, &c., will augment its validity, and serve as a bond to attach them to peace, and render more difficult a general war, which civilization should tend to render impossible. France and England, in uniting to secure the execution of the work, might guarantee also, to the capital engaged in the enterprize, a minimum interest, until the moment when the circulation of the canal should be sufficiently great to render this guarantee useless. An interest of 3 per cent., it appears to me, would be sufficient, particularly when guaranteed by two governments such as France and England. These governments, in thus intervening directly in the execution of the work, and aiding it with their proper means, would acquire, by that act, the right of arbitrating between the government of New Grenada and the Company charged with the execution, of supporting any just demands the Company might have to make on the first, and of insisting with the last on the vigorous execution of all the conditions imposed, and the accomplishment of all promises made, and of overseeing their execution.

One of the first works to be accomplished, as soon as the line of the canal and the situation of the locks shall be decided on, is a road which, following the line for its whole length, will facilitate the transport, to any point, of workmen, materials, provisions, &c. Such a road may be made at an expense of from 1,000,000 to 12,000,000 francs.

The execution of a great canal between the two oceans, such as I propose, will require the simultaneous concourse of a great number of workmen, the greater because the continuation of the rains during nearly six months of the year, from June to November, renders, during that season, all work in the open air impossible; in the supposition that the work is to be accomplished in ten years, it would not

require less than 5000 laborers, 1200 miners, 200 masons, 100 stone cutters, 100 brickmakers, 100 quarrymen, 50 carpenters, in all, 6750 workmen; to which must be added 3 vessels for dredging, and their crews, of which one would be stationed on the Pacific, and two on the Atlantic.

The uniting so large a number of workmen in a country so thinly populated, whose inhabitants are completely ignorant as regards the execution of public works, will certainly be one of the greatest difficulties of this enterprize; this difficulty will be augmented by the heat of the climate, and the insalubrity which is generally, though somewhat erroneously, attributed to it. The yellow fever, that cruel disease, so much dreaded by Europeans who come to the Gulf of Mexico, does not exist in the isthmus of Panama. Chagres, which is always represented as a "pest-house, as horrible to see as it is dangerous to inhabit," is the only really unhealthy place of the isthmus, and what has been said of that has been greatly exaggerated. Its insalubrity which exists only in the rainy season, more especially from July to October, displays itself in remittent fevers, and is due to the presence of stagnant waters, for the draining of which nothing has been done. Moreover, Chagres is avoided in the route I propose, and there is nothing on the borders of the bay of Limon, where the entrance of the canal will be placed, to occasion the slightest uneasiness. As for the interior of the isthmus, I can affirm, that in all my numerous explorations of it, made, it is true, during the dry season, I have seen nothing to authorize a charge of insalubrity. Some large swamps are found on the borders of the Rio Trinidad, but they are a long distance from the line of navigation, which does not cross any one of them, and there is no reason to fear that the canal between the two oceans is to be made only at the sacrifice of the lives of thousands of human victims, or that, when once made, it may not be traversed without danger to life or health. In a word, the climate is not such as to inspire dread to emigrant workmen. A few simple precautions will be sufficient to protect them from the influence of the elevated temperature. Nevertheless, it does not appear to me prudent to expose European workmen, without shelter, to the action of the burning sun of the isthmus, and the successive influences of heat and humidity, two principal causes which, united, often produce fevers. One of the conditions of the execution of the canal should therefore be to employ in the work of excavating and embanking (terrassements) but the laborers of the country, or at all events, those already acclimated to these high temperatures, and to bring them either from the isthmus itself, from the neighboring small republics, or even from the southern part of the United States. It will be sufficient to put over them a certain number of Europeans, as master workmen or guides. One advantage of this measure will be the power of sending these laborers to their homes during the rainy season, when working in the open air is impossible.

All the workmen whose employment demands an apprenticeship, such as masons, carpenters, &c., must be brought from Europe or from the United States. These, it will neither be difficult nor expensive to shelter from the sun and rain, under vast sheds, tents, or even under

portative roofs. It is with a view to such an emigration, that I have placed the wages of these workmen much higher than they receive in France. These wages ought to be sufficient to draw them, as the climate, as I have already said, is far from being as bad as it has been hitherto represented, and much less fatal than that of the Antilles. To favor, moreover, this emigration of workmen, they might be offered a temptation that has in general a great effect on men accustomed to live in society, that of landed property. It would be sufficient to accord to them a certain extent of land, from that conceded by the government, and to increase the allowance in proportion as the length of time they continue in the service of the Company increases. I do not doubt, but that a great number of workmen, having thus become landowners, would decide to continue to inhabit the isthmus, even after the canal shall have been finished, and would thus form the nucleus of an active and laborious population, who would, in a little time, change entirely the face of the country.

The sparseness of the population of the isthmus, and the almost entire absence of culture, which is of very limited extent, especially in the portion of the isthmus where the line will run, a portion almost entirely covered with vast forests, has led to the idea that there would not be found sufficient resources for provisioning the large number of laborers who would be suddenly brought there. This fear, though apparently well founded, is not so in reality. The fertility of the soil of the isthmus is indeed remarkable, and eight months would be more than sufficient to cover ground now occupied by almost impenetrable forests, with magnificent fields of rice, Indian corn, bananas, sugar cane, &c. Certain cantons of the provinces of Panama and Veragua, situated to the westward, possess vast savannahs, where numerous herds of cattle feed, which are often killed merely for their hides. If we add to these the hogs, which are also found in great numbers, we will have every thing that is necessary for the nourishment of the people of the country. For the workmen from Europe and the United States, we must add wine, which will be brought from France, and flour, which will be furnished by the northern States. For these provisions, the former decree of this government granted an entrance free of duty, and certainly the same privilege will be stipulated for in favor of a Company presenting itself with the support of France and England.

The Gauge Commission.

Analysis of Evidence given before the Royal Commissioners appointed to investigate the subject of the diversity of Railway Gauges.

Robert Stephenson, Esq.: Witness's father, Mr. George Stephenson, was chief engineer of the Manchester and Liverpool Railway, completed in 1830. The gauge of 4 feet 8½ inches was adopted by his father, as it was the original gauge of the railways about Newcastle. The Manchester and Liverpool was the first line in this country worked by locomotive engines. After the Liverpool and

Manchester had been established, it was considered imperative that all the lines in that neighborhood should be of the same gauge.

It is difficult to say where a break of gauge in the northern lines could have been made with the least inconvenience, as it involves the question where is the line of minimum traffic. When traveling on the Manchester and Liverpool railway, before laying the gauge of the London and Birmingham, it appeared to witness, as an engine-builder, when called upon to construct engines of greater power, that an increase of three or four inches in the gauge would have assisted him materially, but since, the improvements in the mechanism of the engines have rendered that increase quite unnecessary; they have ample space and to spare. In the arrangement of the machinery, which is the main question, having reference to the width, the working gear has been much simplified, and the communications in the most recent engines between the eccentric and the slide valve have been made direct communications; whereas, formerly, it was made through the intervention of a series of levers which occupied the width. With reference to the increase of power, the size of the boiler is, in point of fact, the only limit to the power, and they have been increased in length on the narrow gauge; the power is increased by increasing their length both in the fire-box and in the tubes; in fact, the power of the engine, supposing the power to be absorbed, may be taken to be directly as the area of the fire-grate or the quantity of fuel contained in the fire-box. No inconvenience results from lengthening the engines to their present extent, and their steadiness is increased; they are at present 12 feet between the front and hind axles. The increase of length between the axles renders the engines less liable to get off the rails; the short engines on four wheels were liable to violent oscillation when meeting any inequality, the front wheels being sometimes actually lifted off the rail; believes the accidents on the Brighton line and on the Brentwood inclined plane were attributable to this pitching motion. The thickness of the crank of the original engine on the Manchester and Liverpool was 3½ inches. There were various plans of reversing the engine at that time. Every engineer, in fact, at that time, had his own plan; some were extremely complicated, requiring time for the reversing to be effected; they moved, in fact, the eccentric. For a long time they moved the eccentric, which slipped upon an axis, and thereby moved the eccentric from one side of the axle to the other, and consequently reversed the engine; but it required a lateral motion of something like 3½ inches; and there being two eccentrics, of course, the mere act of changing the gear occupied 6 or 7 inches of the axle, independent of the more bulky construction of the apparatus itself. The long engines, if kept within 12 feet, are not more likely to get off the rails at curves than short ones.

The resistance in passing round curves is materially affected by the width of the gauge. In the collieries about Newcastle, where the 4 feet 8½ gauge prevails, wherever they come to any mining operations where the power to be used is that of a horse, or a man, they immediately reduce their gauge, because they want to go out and in

amongst the mines with very sharp curves, and the wide gauge would be quite impracticable amongst those. In fact, the small carriages that are used in the mining operations, are upon a gauge of about 20 inches, and they go round curves under ground of about 10 or 12 feet radius; and they could only work such mines by such a gauge. It is quite obvious that the width of gauge must limit the curve. In the case of every gauge at a sharp curve, the outside and inside rail are quite brightened by the sliding motion, because the one set of wheels has to slide forward to keep pace with the other, and the others have to slide backward. In fact, when going round a curve, both operations have to take place,—the sliding backward of the one set and the sliding forward of the other. Of course, as you increase the width of the gauge, the difference between the two becomes augmented.

Is chief engineer of the Northern and Eastern Railway, and was at its construction. Adopted the 5-feet gauge in consequence of its being brought into connection with the Eastern Counties line, which had been laid down with that gauge by Mr. Braithwaite, and with the same view he laid down the 5-feet gauge on the Blackwall, in case there should be connexion between them hereafter. The gauge of the Northern and Eastern and Eastern Counties lines has recently been altered under his direction; when the extension of the Northern and Eastern was considered, and that junction with the narrow lines in the Midlands would take place, a change was thought absolutely necessary, and the same change was also decided on for the Eastern Counties, from the inconvenience of blending two gauges at the Shoreditch station; the expense of a separate carrying establishment would have been greater than the cost of alteration, which was £52,000. Of course it involved the necessity of working upon a single line of rails; the establishment was divided into two parts, one of which was retained as available for the 5-feet gauge, whilst the other half was altered to be ready to work upon the other line, which had been converted into the 4-feet 8½ in. gauge, therefore the alteration from one gauge to the other was to take place in one night, in fact, between the two trains, the last at night and the first in the morning.

The whole distance was 88 miles. The operation occupied about six weeks altogether, but preparations were made beforehand. The alteration was made entirely under his superintendence, and the rails being on transverse sleepers facilitated it materially. No new rails were required, and the boilers being of the same size as those on the 4-feet 8½ in. gauge, the engines could be converted.

Considers it would be advisable to run the same carriages from Euston-square to Edinburgh and Glasgow, were a railway complete. There are men at different stations to see that nothing is wrong, and the carriages, both for passengers and goods, are now so substantial, that they may run many thousand miles without anything but greasing. Goods wagons go at less velocity, and would probably stand it better. The carriage is now much more judiciously constructed than formerly. The strength of carriages conduces very much to safety in case of accident, and the plan of making the under frames of carriages of wrought iron instead of wood, will be carried out to prevent the

harm at present done by splinters. Is projector of the Chester and Holyhead Railway, and will use the 4-feet 8½ inch gauge, that carriages may run from Euston-square to Holyhead; any change would interfere with communication to Ireland. His father and he were consulted as to the lines from Antwerp to Brussels, and from Liege to Ostend, and he was connected with the Leghorn and Pisa, and recommended the 4-feet 8½ inch gauge, as it had been found in this country to answer every purpose. An inch or two, more or less, would have involved a different construction of engines, and he saw no reason for altering that which had been established by experience. Was consulted on the Belgian railways, and on the Leghorn and Pisa. When giving his opinion as to the Belgian lines, the Great Western was not opened, but in reference to the Italian line he had seen both gauges in operation.

Is not aware of any advantage the Great Western possesses, and it has several disadvantages; the additional expense of construction, as in embankments, cuttings, tunnels, bridges, and viaducts, and also in carriages, engines, tenders, workshops, and stations, everything being on an increased scale. The sliding-frame system has to be introduced instead of turn-tables, so that the management of the station is more expensive. Thinks the tear and wear of the carriages on the Great Western is as much as on the narrow lines, and the resistance of the wide carriages is greater; there is more friction of the wheels on the rail to be overcome. The increased expense of the carriage department on the wide gauge would not be in the haulage per mile, but in the fixed establishment of engines. Even the increased boiler, (4 feet 9 inches) of the Great Western would, as nearly as possible, go into the narrow gauge. While he thinks the Great Western has no advantages by the wide gauge, its introduction has involved the country in great inconvenience; if a meeting of gauges takes place in the midst of great traffic, canals would have a decided advantage over railways; the system of boxes and loose-bodied wagons for the transfer of coals has been tried and failed. The loose-box system involves the necessity of increasing the number of carriages on the railway very materially. At Erewash the coal-owners could not avail themselves of the railway, and sent the coals by canal. Coal-owners would prefer transferring their coals from railway to canal, to moving them from one railway to another, on the loose-box system, as by the latter they would lose control over their boxes; they would prefer the transfer by hand, from one railway to another, to loose-boxes. The American railways are universally of the 4 feet 8½ inch gauge. There is a railway from Basle to Strasbourg of 6 feet 3 inch gauge, but parties there deeply regret the alteration, as they look forward to a transfer at each end. There is a line laid down by Deridder, from Ghent to Antwerp, of 3 feet 9 inch gauge; traveled with him on part of that line from Brussels. Has seen, at the Paddington terminus, the modes proposed to supersede the necessity of removing goods and passengers at the junction of different gauges, and believes it would answer the purpose as far as machinery could, but seeing one or two transferred does not convey the amount of inconvenience incident to transferring 100

coal wagons. The other mode of transferring by running the train on another set of trucks, would increase the dead weight to be drawn, so as to be highly objectionable, and the increased height would prevent some classes of goods from getting through the bridges and tunnels. The London and Birmingham goods-wagon, properly laden and placed on the Great Western truck, could not pass under their bridges. The expedient at the Great Western terminus for diminishing and widening their gauge wheels may be safe, but being complicated, he thinks it would not keep in good order; it would also be an expensive arrangement. A modification of the sliding axle was tried on the Newcastle and Carlisle, and soon abandoned. Has not been able to think of any expedient to avoid a transfer; he has seen various ones contrived; the one by Mr. Harding, of the Bristol and Gloucester, is as good a mechanical expedient as any, but that would be so objectionable as to lead to the actual transference of goods in preference. An arrangement at the Birmingham termini for lifting goods-wagons from one level to another is the simplest operation, but if they had to be put on different wagons, the evil would be very much aggravated; even with regard to Birmingham, the inconvenience of the lift is so great, that it is to be abandoned, and an inclined plane substituted.

Is still a locomotive engine-maker, and is of opinion that the 4 feet 8½ inch gauge gives ample space to get the utmost power necessary for working ordinary trains; at present there are, he believes, more powerful engines working on the narrow than on the broad gauge lines. The cylinders of those engines are 16 inches in diameter, the length of stroke is 24 inches, and the wheels vary from 4 feet 6 to 4 feet 9 in diameter. They are all six coupled; and those engines are as heavy as the present rails will bear. They weigh from 22 to 23 tons; I believe the same weight as the Great Western engines. There is now as great a weight upon six wheels upon the narrow gauge as ought to be put upon six wheels; and that will be hereafter the limit of power, not the width of gauge; engines may be built upon the wide gauge, no doubt, heavier and larger in dimensions, and more powerful, but then you must make a road to support it on purpose. The weight of the rails is 75 pounds to the yard; 65 have been used. The width between the bearings varies from 3 ft. to 2 ft. 9. Thinks the narrow-gauge lines best calculated for carrying weight without injury to the road, and the transverse-sleeper system is better for keeping the rails in order than the longitudinal bearings. The expansion and contraction of the iron tend to disturb the action of the sleepers. Instance on the Peterborough line, where the rails had been laid too close, and acted on by the heat of the sun, raised the sleepers three feet into the air. Locomotives can be manufactured for the narrow gauge capable of attaining as high velocities as those on the broad; they are now running upwards of fifty miles an hour, with engines not made for maximum speed. No difficulty in making a narrow-gauge engine to take 40 tons at sixty miles an hour, or more; the engines on the Great Western were made for greater speed, but the average on it was the same, or a little under the Northern and Eastern.—The

average speed of the Great Western is greater than on the London and Birmingham, except for mail trains, which are precisely alike.—Has worked the express trains on the narrow lines with as much economy of coal, &c., as on the Great Western. The express engines on the Birmingham are smaller than others, weighing only 12 or 13 tons, and costing about £1300.—Should recommend those weighing 17 or 18 tons, and costing about £1650. Thinks the public safety would be endangered by having the bodies of the passenger carriages movable at a change of gauge; any slight collision, not otherwise dangerous, would throw them off, besides the risk of porters neglecting the fastenings of each. Would never incur the responsibility of having the bodies separate from the under frames, as, besides other objections, the under frames would be more liable to derangement. The complexity of the broad and narrow gauges in the same station would be great; the turn-table, a most invaluable machine, must be abandoned. Combining two gauges, by laying the rails of one centrally within the other, would get rid of some of the difficulties, but not at stations. Turn-tables could be used, but already in the wide gauge system, they are beyond the pale of turn-tables, from the distance between the fore and aft axles of wagons.

In changing from a narrow to a broad gauge line, believes the least evil is to transfer every thing, changing the carriages and moving the goods by hand; with reference to general merchandize, has heard Mr. Brunel express the same opinion. Thinks it would be better to have two rails for the narrow laid within those of the broad gauge, than to have only one, and to use one of the broad gauge rails; as in the latter way, the two trains could not accompany each other, the centre of gravity not being in one line. If the engine were at the head of the trains, it would be of less consequence than if they were propelled from behind. A double system would be required to drive each carriage from the centre, and this is a matter of serious expense. Witness would lay down the narrow within the broad gauge, on the transverse sleepers, and the cost would be about £4000 a mile, or more, in addition; Mr. Brunel estimates a single line additional at £2500, besides the extra cost of station. This is on the supposition that the broad gauge is first laid down on transverse sleepers, but the expense would not be materially different in either case. The rails would not be packed well with longitudinal sleepers, on both systems. In adding a pair of rails within the broad gauge, witness would lay down the transverse sleepers independently; for with other longitudinal sleepers, there would not be room for another bulk like the present, and the ballast of the weight would not be in the centre. Could not mix the systems of sleepers, on account of the length of the transverse, which would almost cut the longitudinal in two. It would be impracticable to lay down the broad on the narrow gauge, without sacrificing one line in tunnels, which would, from danger, amount to a prohibition. On the narrow gauge, 24 feet are required for tunnels, and on the Great Western 4 feet to 6 feet more. Four feet is the minimum space between the two, just room for a man to stand, and the same spaces at each side of the tunnel, and any diminution would

be fatal. Recesses might be made at intervals, to meet a diminution, but a man might not be near a recess when the train came. Recesses could be made after the tunnel is formed, but in many cases the brick-work would thereby be much injured. Impossible to place the broad gauge on the London and Birmingham, without enlarging the tunnels and closing the line for two or three years. Would rather make a new one than enlarge the present Kilsby tunnel. A cutting could not be kept open there, and it would be a gigantic work. With reference to the present and future meeting of the broad and narrow gauge lines, does not apprehend much interruption to the express and other passenger trains at the point of junction, if they are made at the proper places; thinks Bristol and Oxford two places where the two gauges ought to meet, as at these two points he believes there is the least quantity of cross traffic; this explained by witness.

The principal Midland Counties traffic, from Rugby to the Great Western, supposing the double line were constructed from Oxford, would be coals going towards Oxford, and corn coming back. Looking to Southampton as the port, it would only require, supposing the narrow gauge carried down to Oxford, a line from Oxford to the South Western to complete the narrow gauge system, over the kingdom, as far as Southampton is concerned; the Great Western Company have a line from Reading to Basingstoke, and if that were laid on the narrow gauge, and the double system from Reading to Oxford, there would be no break in the country at all; commercially, Southampton, London, Bristol, and Liverpool, would interchange with each other, and with the manufacturing districts, by the same carriages. No extension of the wide gauge towards the London and Birmingham would relieve Lancashire or Yorkshire from a change of gauge, but an extension of the narrow from Oxford to Basingstoke would relieve the whole question of embarrassment. The Great Western Company can be compelled to lay down the double gauge from Rugby to Oxford, and on the greater portion from Wolverhampton to Oxford, and to Worcester, as they agreed to do that. The loss of time in transferring a passenger train at Rugby to go to Oxford on the broad gauge, would depend on the amount of passenger traffic; it is a point of small passenger traffic; it may be a large one of coals and corn; the extension of the wide gauge into that district must multiply the points of junction of the two gauges, and the chances of interruption: passenger trains could not be changed in less than half an hour. Has experienced the inconvenience of changing carriages, and scrambling for luggage on the Belgian railways, at Malines. Was detained the last time about half an hour. If the change of gauge took place at Rugby, a new station would be required.

With regard to agricultural traffic, at any point of change, the beasts would require to be grazed before removing them from one carriage to another, and is afraid the loose bodies would be required for pigs; they could not be managed otherwise; they must be lifted *en masse*. The wagons themselves upon the narrow gauge vary from 2 tons 10 cwt. to 3 tons; some recent large ones run as far as 3 tons 10 cwt., and they will carry 5 and 6 tons of goods. I think the latter is as

near two to one as possible; that is, that if the dead weight is one, the useful weight is two. The difference is here against the broad gauge: the trucks for intermediate traffic seldom average more than a ton each, so that all the intermediate traffic on the Great Western is carried on with trucks of five tons, with one ton of goods in them. As railways extend into every corner of the country, the advantages of the narrow gauge would be most apparent, and as the wide is more expensive than the narrow, the former would limit the ramifications of railways. The narrow gauge wagons are infinitely superior for mineral traffic, particularly coal; if the mixed gauge system be allowed to extend in this country, the charge on coal will amount in many cases to a prohibition. Thinks the broad gauge has a disadvantage as to horse-boxes; their motion is sometimes fearful; they want length with reference to their width, while on the narrow gauge a carriage of the same length might be very steady. Prefers the narrow gauge passenger carriages, carrying three in width, to those of the wide, carrying four; the latter are cold in winter, and want ventilation in summer. There has not been so much attention paid to the construction of the narrow gauge passenger carriages as to the broad, but the narrow could be made 6 feet high, so that a person might stand up in them. The lowest longitudinal distance between the axles of 4 and 6 wheeled engines on the narrow gauge, is 10 feet, and the highest 12 feet 9 inches; the last are too long; witness adopts a maximum of 12, and a minimum of 10 feet; relatively the centre of gravity is the same height in both gauges. Though there would be great difference as to the cost of constructing the broad and narrow lines, cannot say there is any difference in the cost of working. Whether the traffic be much or little, it is merely a question of expenditure of power, and though the most powerful engine is cheapest to work with a proportionate load, each may have engines of the same power.

The wide gauge engines are not more powerful, but are heavier in proportion to their power; everything in the width gives the engine no power at all, but is an encumbrance. Neither commercially nor mechanically has the wide gauge any advantage over the narrow, but rather the contrary. The driving wheels of the broad gauge engines are not generally of greater diameter than the narrow; 6 and 7 feet engine wheels are used on the Great Western. The greater diameter of the driving wheels has a tendency to reduce the axle friction; but comparing 6 and 7 feet, the amount of this is not worth measuring, but if by increasing the gauge, the axle has to be increased in size for strength, what is gained on the one hand is lost on the other. The friction of the flange of the wheels against the railway has a retarding effect on curves, but not much on straight lines. Any lateral friction arises from the angle of the wheel against the line, and must be greater on the wide than the narrow gauge; around curves the sliding motion must be directly as the width of the gauge.

The evaporating power of a passenger engine on the Northern and Eastern, is about 130 cubic feet an hour; he has some evaporating 160 feet. The most powerful engines are constructed with either outside or inside cylinders; the largest are inside. Certainly, some en-

gines that have been recently made with outside cylinders have much more of that motion than I like. It is exceedingly difficult to say how the motion is produced; if you consider the action of the cylinder, it is perfectly rigid metal—engine and cylinder altogether. Now, when the steam presses upon the piston, it is at the same time pressing against the lid of the cylinder; the action and reaction must be equal. Therefore, that it is not the steam that causes the irregular action, but the mere weight of the pistons themselves, and therefore if we could contrive to balance the pistons by the weight upon the wheel, we should get rid of that very much; but in the most recent designs of engines of that kind, he has brought the cylinder much nearer to the driving wheel, and nearer to the centre of the engine; at present they hang over the wheels a good deal; now he has brought them within the wheels.

It is now an indispensable part of the broad-gauge system to use the longitudinal bearings; it is a question of expense. As you increase the width of the gauge, of course, on the longitudinal system, it leaves the expense the same; whereas, if you adhere to the transverse system, you increase the size, and of course, you increase the expense more rapidly; therefore the transverse system with a very wide gauge would be very objectionable on account of its expense, but I think the principle of construction would be better. With reference to the maintenance of the way, imagines that the way is kept in better order upon the tranverse system than upon the longitudinal at the same expense; has never seen any portion of longitudinal bearing railway in perfect order. It is more difficult to pack, and there is always more friction in a longitudinal railway than in a sleeper railway. The Hull and Selby is part of it longitudinal and part of it transverse. The engines where they were heavily laden, upon the longitudinal bearings would just creep along; the moment they got to the tranverse bearings they went 5 or 6 miles an hour more directly, from the yielding in one system, which gives a little less noise and a little softer motion which the Great Western has. Does not think in that particular case it resulted from the longitudinal bearings being of insufficient dimensions and slighter than the Great Western, thinks they were the same size;—Memel balks, 12 or 14 inches square, cut up; and the Great Western are 14 inch balks. In the longitudinal system there is a little less noise, and there is a little softer motion than upon the transverse system, but there is a great deal more motion; there is far more actual motion upon every longitudinal railway than upon the transverse sleeper system.

If the London and Birmingham had originally been made on the broad gauge, estimates that it would have cost about 3000*l.* a mile more, without including the additional cost of the central station at Wolverton, which must have been much larger. As to altering the existing gauge on the London and Birmingham, thinks it would stop the line for at least two years, that it is practically impossible. It would cost about 15*l.* a yard for tunnelling, taking good ground and bad. To make the Kilsby tunnel as large as the Great Western tunnels, it would have cost a great deal more than that. On the other

hand, in increasing the size of the tunnel in good ground, such as chalk, the additional cost would not have been so much. States the results of experiments, showing the consumption of fuel and water, by an engine with different load. Found that the consumption of fuel for drawing the engine without a load, was equal to about the consumption of fuel to overcome a load of 15 carriages at 30 miles an hour; that is, it took as much to move the engine and tender as it did additional to move 15 carriages. There have been many reasonings upon that without considering the precise application of it. A large proportion of the fuel in moving the engine alone is consumed in overcoming the resistance of the atmosphere to the pistons; it will not require more than three or four pounds to overcome the friction of the engine and tender proper, but it requires 15 pounds in addition to that to overcome the engine and tender, taking into account the atmospheric resistance to the piston; so that there is always 15 pounds of pressure of steam in all high-pressure engines absolutely lost; it is not the friction of the engine; certainly it is a defect in the engine from its being a high-pressure engine, but on no other account. It is not a peculiar loss applicable to locomotive engines alone, but to all high-pressure engines; and therefore in estimating the consumption of fuel and dividing the proportion of expenses, it became important to ascertain what was the relative expense of conveying 8 carriages, and of conveying 15, because all the trains of the Croydon Company were small, and all the trains of the Dover Company were comparatively large; and from this experiment it appears that as to the cost of coke, whether to convey 8 carriages or 15, there is a very small difference. Therefore, if you proportion your expenses by the load, you give the small load very greatly the advantage, because you charge them only half the fuel, say as 8 is to 15, whereas you ought to charge them as 8 plus the engine is to 15 plus the engine, which will make a very great difference.

Believes the gauge of the Dutch railways, constructed in 1842, to be 6 feet 5½. The Amsterdam and Haarlem Railway is essentially level, and laid on longitudinal timbers, which are best suited to the unsound ground of Holland. The line laid over Chatmoss is laid on transverse sleepers, but the moss there has much more tenacity than the substratum of peat in the low part of Holland. Mr. Conrad constructed or projected the line in Holland; he examined railways in this country, but does not know whether he was assisted by any English engineers.

(To be continued.)

Blasting Shoals in the River Severn.

At the Institution of Civil Engineers, on Wednesday night, the paper read was by Mr. G. Edwards, member of the Institution of Civil Engineers. It described the method employed for breaking up the shoals in the river Severn, between Stourport and Gloucester. These shoals consist of marl rock, so compact and tough as to resist all attempts to break it up with the stream dredger, or by prize bars,

or with a powerful species of subsoil plough. Recourse was therefore had to blasting with gunpowder, and the process of these operations formed the subject of the paper. Messrs. Grissell & Peto were the contractors for the work, and for them Mr. Edwards designed and executed the blasting operations. A series of rafts were moored in a line over the shoal, parallel with the bank of the river. Along the centre of each raft there was an opening, through which wrought iron tubes, 3½ inches diameter, were driven down, at intervals of six feet apart, through the gravel down to the marl; withinside these tubes the workmen used the chisel-pointed jumper to make the shot holes, to a depth of six feet below the surface. The loose stuff was extracted by an auger. A tool cartridge of canvas well pitched and tallowed, containing three pounds of powder, was lowered through the tube into the hole, which was well rammed with loose marl. The charge was then fired by means of Bickford's fuse. There was generally but little apparent external effect from the shot, except lifting the pipe a few inches. But sometimes a column of water would be driven up through the water to a height of forty or fifty feet. It was found that each shot had loosened a mass of marl of conical or parabolic form, of which the bore hole was the centre, and its bottom the apex, so that four adjoining shots of two parallel lines would leave between them a pyramidal piece of marl, which was removed by the dredging machine with the loose stuff. This operation of blasting was repeated in parallel lines along all the shoals, and the stuff was dredged up at the rate of 200 to 300 tons per day. The cost of blasting was about 1s. 9d. per cubic yard. It was stated that the six principal shoals had all been successfully operated upon, and great credit was given not only to the design, but also to Mr. Edwards for the systematic and complete manner in which he had arranged and conducted the operations.

The Society showed their approbation of Mr. Edwards' abilities by awarding him the Telford medal for 1845. We may add that many thousand tons of matter have been thus already broken up and raised; that two dredging machines are now regularly employed, and that the works are progressing in the most satisfactory manner. As the tolls empowered by the Act cannot be imposed until there is six feet water from Stourport to Gloucester, every possible exertion is being used by the contractors, Messrs. Grissell & Peto to expedite the completion of the work; two dredging machines have lately been working from 3 a. m. to 9 p. m., indeed, we are informed, one of them No. 1, absolutely raised the surprising quantity of 900 tons! one day last week. A third dredging machine, built by Mr. Rebel, of Gloucester, under the direction of Mr. Edwards, was launched last week, and will very shortly be ready for work. Viewing the magnitude and difficulties of the works we consider it fortunate for the Commissioners that they have been entrusted to such responsible parties as Messrs. Grissell & Peto, who have at their command the means and the talent necessary for anything that may be required to be executed. We are told it is no uncommon circumstance for this firm to have in their employment at one time, on different works, as many as 10,000 men.

Naut. Mag.

On the Profitable Increase in Traffic on Railways as produced by Great Reduction in the Charges. *By* Mr. B. Williams.

The carriage of goods, the original object in the construction of railways, has been kept out of view until lately by the increase in passenger traffic calling for all the energies of the managers, and the entire revenues of the companies, except on the old established lines, where it has been proved, Mr. Williams states, that the increase of nett profits from goods is greater than the increase of nett profits from passengers. Goods of small bulk, compared with their value, may be sent by railway, but not agricultural or mineral produce, generally goods of great weight and bulk in proportion to their value at the present high charges, although a railway is the construction of all others calculated to meet this demand by its mechanical power. It is a great and costly machine or engine, the produce of which is cheap if it be fully employed,—if the machine be idle or work with incomplete action, a loss of interest on the great outlay must be the result. The cost of conveyance on all railways, in Mr. Williams's opinion, admits of being separated into two elements; first, interest on capital, together with certain fixed charges, which are independent of the greater or less use made of the railway; second, the actual working expenses that result directly from the work done. In Belgium, in order to provide interest at the rate of 5 per cent. on the original cost of the railways, with a goods traffic per mile per annum of 40,000 tons (the actual traffic to the year 1844 on the Belgium Railways) the charges would consist of 3d. for interest and other fixed demands, and ¼d. for working expenses, making a total charge of 3¼d. required, with that amount of tonnage, to pay 5 per cent. on the capital. The actual charge was 2½d. per ton per mile, and the railways were then working at a loss, the Government having borrowed the capital for their construction at 5 per cent., and having in nett return, after defraying the expenses, only 2½ per cent. Yet at the very time the railways, with their superior advantages in economy of time and regularity of delivery, were carrying only 40,000 tons per mile per annum, the canals were carrying 400,000 tons. The charge on the latter was 1¼d. per ton per mile, or half of the charge on the railways. Had the railways but carried one-half of the tonnage of the Canal Company at the canal charges, instead of an annual loss to the revenue of 60,100*l.*, there would have been an annual gain of 52,500*l.* Mr. Williams illustrated his paper with various tables and returns, calculated upon data embracing the average cost of railways in England, and funding for interest at the rate of 5 and of 10 per cent. on the capital. The tables showed of how much importance it is for the benefit of the public, consistently with the pecuniary interest of the capitalists, that large quantities of goods should be carried;—that, for example, while, with an average traffic of 100,000 tons per mile per annum, the charge required to produce 10 per cent. on the capital, after paying the working expenses, should be about 4½d., with an annual traffic per mile of 500,000 tons, a charge of 1¼d. per ton on the average of all goods would produce an equal return after paying

the expenses. This subject was pursued, illustrated by tables, with reference to the conveyance of passengers, of various classes of goods, cattle, &c. The applicability of these tables to test the substantial character of new schemes was made apparent. A necessary conclusion of Mr. Williams's investigation is, that expansibility in the railway system (both as regards the mechanical power and the mode of management) is required ; and that it is the interest of the companies to increase, in a great degree, both the goods and the passenger traffic by a system of low charges. It is to the interest of the public that as much traffic as possible should belong to each line, and thus competing lines are highly injurious to the public, by preventing the reduction in charges that can only be the result of the conveyance of numbers of persons and quantities of goods ; in other words, the machine should be kept fully employed.—*Trans. Statistical Soc.* Athenæum.

Improvement of the Clyde Navigation.

The discussion upon the improvement of the Clyde Navigation was renewed by a statement from Mr. Atherton, formerly resident engineer of the Clyde under Mr. Telford. He gave a brief exposition of the past history of the Clyde navigation, from the time when the only craft on the river was a few herring boats, and the water was suffered to overflow a wide extent on either side of the channel, converting it into an extensive morass. He then gave the various projects for improving the navigation—Smeaton's design for a lock on the main channel, which fortunately was never executed. To Rennie, it appeared to be universally admitted, must be attributed the credit of propounding the general principle of the Clyde improvements, which were commenced under him, and were so successfully continued by Telford and others. Rennie's principle was, that the whole surface waters of the river should be brought within definite limits; that in the lower parts those limits should be very spacious, but gradually and equally diminishing upward, not by sudden *intakes*, but by gradual convergence of the restricted width. By this principle, the current of the land flood being concentrated, their power of augmenting the depth of the channel would have full opportunity of acting beneficially. It was also expected, that the rising tidal waters, entering between the widely extended limits of the lower districts, would expend their momentum as they ascended the conveying channel, in raising the height of the tidal wave, and produce an effect analogous to the extraordinary elevation attained by the tides in the Severn, in consequence of the gradual convergence of the shores of the Bristol Channel. Thus, the land floods and the sea tides were to combine in producing useful effects—the velocity of the former in deepening the channel at low water ; the latter in preserving or continuing the surface of high water, even to Glasgow, at the estuary level. The difficulty was in commencing the works without funds ; they were, however, begun in an economical manner, by running out jetties of fascines of wood and stone, from the opposite sides of the river, so as

to bring the channel within certain limits. The effect of these jetties was to commence the deepening of the channel, by increasing the scour. Owing to the increase of manufactories, and of the iron and coal trade at Glasgow, shipping began to frequent the river; the port dues were kept low; and an annual revenue commenced; greater exertions were made to increase the facilities for admitting ships of greater draught. Telford followed in Rennie's footsteps, by uniting by stone dykes longitudinally the extremities of the projecting jetties: steam dredging boats were employed to cut away the shoals, and diving-bells to remove the rocks which impeded the free current of the stream. Walker followed the same course, and the result was, that the depth of water was so increased, that instead of only being capable of receiving fishing-boats of a draught of water of under 6 ft., vessels drawing 17 ft. were tugged by steamers to Glasgow quays, and the annual revenue of the port at present exceeded 50,000*l.* The speaker proceeded to comment with eulogy upon the proceedings of the Clyde trustees and their engineers—and dissented from the views of the Tidal Harbor Commission, in their recommendation of opening up the river for the free admission of the tidal water, so as to cause them to act by reflux; which it was contended by the speaker generally would not be so effective, as continuing to improve the channel, and persevering in the same course which had hitherto proved so effectual. Some discussion ensued, as to the propriety of some measures being adopted in certain parts of the river: but it appeared generally admitted that the work, so wisely conceived, had been very ably conducted, and that the results were to render the Clyde a model for works under similar circumstances.—*Trans. Ins. Civ. Eng.*

Min. Jour.

On the Lines of Propulsion in the Steamboat, Locomotive, &c. By T. W. Bakewell, Esq.

The writer is not aware of any scientific examination to determine the points through which the lines of propulsion pass—as respects a steamboat, a railroad locomotive, or a boat when rowed.

The erroneous opinion prevails, that the lines of propulsion in the above cases, are in the axles of the wheels, with the steamboat and locomotive,—and in the gunwale of the boat on which the oar rests.

The line of propulsion of the steamboat is in the paddle, at the centre of percussion, beneath the surface of the water. The locomotive has the lines at the circumference of the driving wheel, where it touches the rail, and its direction is parallel thereto. And the row boat has the line at the end of the oars in the water.

In the locomotive, for instance, this principle may be plainly perceived by supposing a rope made fast ahead, stretched along the rail, and passing under the wheel,—so that the locomotive should advance by winding the rope round the wheel, instead of by adhesion on the rail.

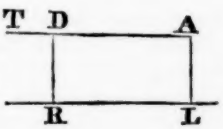
Now it is evident that the line of propulsion remains unchanged—

whether the locomotive advance itself, by drawing on the rope, or the wheel be made stationary by the steam on the engine opposing an active force at the end of the rope, which should advance the locomotive.

As to the row boat, it is true,—if we row on the larboard oar, the boat will turn to the right, but not because the line of propulsion is in the larboard gunwale—for if we raise a place for the oar, on the starboard gunwale, so that the oar can pass freely over the boat and larboard gunwale into the water—and erect a stage outside the boat, on the starboard side, to enable us to work the oar—the boat will still turn to the right, although in this arrangement the oar rests on the starboard gunwale.

The practical benefit resulting from a consideration of the above facts may not be important; with the locomotive, however, they may be worthy of note, as they show that the pressure of the driving wheel on the rail, for friction, is influenced by other causes than the weight borne by itself.

Let R to L, be the propelling force on the rail, and A to D, the equal resisting force of the train T. Let D R, be the position and direction of the weight on the driving wheel, and A L, of the weight on the driven wheel, or system of wheels, if more than one.



These forces will always exist, and act in the locomotive, although the lines representing them may not coincide with, or be traced through any material in its construction—and there are several views by which we may arrive at their effects. Let it suffice that we have the crooked lever R D A, whereof R, the bottom of the driving wheel on the rail, is the fulcrum.

Then by the opposing forces R L, and A D, the proportion of weight transfered from A L, to become pressure on D R, will be inversely as A D, to D R.

Now we can suppose forces R L, and A D, to be of sufficient intensity to raise A L, from the rail, when the whole weight would be converted into pressure on the driving wheel. In case the locomotive should push the train, or draw it, having the driving wheel in advance,—the pressure on it would be lessened according to the above law, in its reversed action, and the fulcrum would be at L.

AMERICAN PATENTS.

List of American Patents which issued in the month of September, 1845. *With Exemplifications, by* CHARLES M. KELLER, *late Chief Examiner of Patents in the U. S. Patent Office.*

Continued from Page 216.

29. For an improvement in *Stoves;* Peter J. Chute, Schenectady, New York, September 19.

Claim.—"What I claim as my invention, and desire to secure by

letters patent, is the arrangement of the dumb flues surrounding and within the oven, in the manner and for the purpose set forth."

These dumb flues communicate with the horizontal flues at bottom, and are closed at top, so that there is no circulation through them; they are necessarily heated by radiation from the main flues.

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30. For improvements in the *Hot-air Furnace for Heating Buildings;* H. L. B. Lewis, New York City, New York, September 19.

Claim.—"What I claim and desire to secure by letters patent, is 1st, the *gate* and *agitator;* the bars of the latter working with freedom between the bars of the former, in such a manner as to free the coal of ashes, so as to insure active combination.

"2d. Also, the arrangement of the collars, containing a number of holes in combination with the combustion cylinder and zigzag smoke pipes, for the purpose of preventing the too rapid escape of air into the apartment next above, before it is sufficiently heated.

"3d. Likewise the arrangement of plate B, in combination with the combustion cylinder and smoke pipes, as described.

"4th. And also the arrangement of plate C, containing the register for regulating the draught through the coal, in combination with the register, and smoke pipes, and combustion cylinder."

The improvement covered by the first claim needs not to be described. That covered by the second claim consists of two perforated horizontal plates to intercept the current of air as it passes up through the chamber surrounding the fire-box, when this is combined with the pipes in the apartment above, which are elbowed to increase the heating surface, and which also impede the escape of the air. The third claim is for combining with the elbow pipes a circular plate with holes, by which the passage from these pipes can be regulated at pleasure. And the fourth is for combining with the above arrangements a register plate, for regulating the admission of air to the grate.

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31. For an improved method of *Combining and Connecting Cranks and Crank Pins of Steam Engines;* Frederick E. Sickels, New York City, New York, September 19.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is connecting a crank pin with two cranks, by means of turning and sliding joints combined, whether the pin be made to slide in both cranks or only in one, so as to equalize the strain of the engine on each crank, and allow them to move and compensate for any error in the relative position of the crank shafts, as herein described."

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32. For an improvement in the method of *Hanging Doors;* Aaron B. Carpenter, New York City, New York, September 19.

Claim.—"I do not claim to have invented any of the parts herein described and shown except as follows:

"I claim as new and of my own invention, and desire to secure by letters patent, the application of the movable hanging stile, hinged in

a rebate in the doors or sash stile, and steadied in a groove in the jam by screws, either without or in combination with the springs H and K, and roller I, and inclusive of any variations arising from the nature of the particular case, when such application and combination or variations, for the purposes herein described, are substantially the same in construction and practical effect, and shall be used in hanging or mounting French sashes, casement windows, or folding doors, of any description and for any purpose."

The casement, sash, or folding doors, instead of being jointed to the permanent frame, are hung to a "stile," which slides in a rebate, and provided with springs that force together the two halves of the door, or sash, when closed, to insure a close joint.

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33. For an improved method of *operating the Drop cut-off Valves of Steam Engines;* Frederick E. Sickels, New York City, New York, September 19.

The patentee says:—"By the method now practised of operating the drop cut-off valve, the motion is derived from the lifter, which approaches its state of rest as the piston of the engine approaches the middle of its stroke, or its maximum velocity, and the valve is tripped by the same motion which lifts it, so that there must be very great nicety in the adjustment to regulate the extent of the cut-off at about the half stroke. The object of my invention is to remedy this, and its principle or character consists in tripping the valve by a motion independent of the motion of the lifting-rod or rods. And, also, in combining the various parts in such manner as to regulate the cut-off with accuracy during the action of the engine, by connecting the two shafts that trip the two cut-off valves end to end, by means of adjustable spring arms that take into, and are, when set, held in the teeth of a sector, which vibrates on the axis of motion of the shafts, and receives its vibratory motion from the eccentric,—which spring arms may be shifted in the teeth of the sector, brought nearer to, or farther from each other, and thus cut off at a less or greater portion of the stroke."

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34. For a method of *Casting the Steam Chests with the Cylinder, and with the Cylinder Bottom and Condenser;* Frederick E. Sickels, New York City, New York, September 19.

The patentee says:—"In forming the connexion of a steam cylinder with the steam chests of puppet valve engines, it has long been known to engineers, that the closeness of this connexion is important in an economical point of view, not only on account of the weight and cost of materials employed in making a long connexion, but because all the steam contained in this connexion is condensed or otherwise lost at each stroke of the engine; and hence various devices have been resorted to by engineers to surmount this difficulty—the steam chest has been variously arranged and located; but still all these devices have presented a large area between the chest and the cylinder, for the steam chest being cast separate from the cylinder, sufficient

room must be left to form the connexion by bolted flanches, which necessarily occupy much room. To remedy these evils is the object of my invention, the nature of which consists in casting the steam chests in one piece with the steam cylinder, or one with the cylinder and the other with the condenser and the cylinder bottom, by making the side of the cylinder the side of the steam chest, and so of the condenser; and also in so forming and adapting the appendages of these parts as to enable them to come together, and to unite the cylinder head with the cylinder, and the cylinder bottom within the narrow compass left between the steam chest and cylinder where they are brought in such close proximity. The flanch on the cylinder and cylinder bottom being dispensed with towards the steam chest, and instead thereof a joint made between the chest and cylinder by packing or driving, and screws inserted from the inside of the steam chest and screwing into the solid metal of the cylinder, for the lower steam chest, and for the upper end, recesses being made in the side of the steam chest to admit the requisite screw bolts for screwing the cylinder head.

"I do not claim letters patent simply for casting the steam chests with the cylinder, or with the cylinder bottom and condenser; but what I do claim as my invention, and desire to secure by letters patent, is casting the steam chests with the cylinder, or one with the cylinder and the other with the cylinder bottom and condenser, by making the side of the steam chest the side of the cylinder or condenser, in combination with the manner of fitting the cylinder head and the lower end of the cylinder to the chests, and the mode of making the attachments without the continuation of the flanches, thus dispensing with the nozles and nozle flanches, and their attachments, and saving at each stroke the steam contained in the nozles, all as herein described."

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35. For an improvement in the *Portable Bath;* Nelson Bartlett, Belvidere, Illinois, September 23.

Claim.—"Having thus fully described my improvements, what I claim as my invention, and desire to secure by letters patent, is constructing the receiver, in the manner and for the purpose described, viz: by supporting its edges with springs, as set forth."

The receiver is made of india rubber cloth with the edges turned and sustained by means of spiral springs.

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36. For a machine for *Grinding Spiral Knives;* William Hovey, Worcester, Massachusetts, September 23.

The patentee says:—"The nature of my invention consists in attaching the twisted (sometimes called spiral) blades or cutters to a flanch projecting from a stock hung on journals in a traversing carriage, so as to present the back of the cutter to be ground to the action of a grindstone, or other reducing or polishing wheel, so that as the

cutter on the carriage traverses lengthwise, it shall vibrate freely on the axis of the stock to which it is attached, to follow the twist of the blade, and grind it to a sharp edge such as is required in cutting, by impinging the cutting edges against the surface of a cylinder by the rotation of the two cylinders or the cutting cylinder on a plane, the cutting being effected by a pressure towards the centre of the axis of the cylinder of knives. The reciprocating motion of the cutters during the traverse motion, being governed by the spiral or twisted surface of the knife itself or any thing analogous thereto.

"What I claim as my invention, and desire to secure by letters patent, is giving to the spiral, or twisted, knife or cutter, attached to a flanch in a line radiating (or nearly so) from the axis of the stock, a traversing motion in the direction of its axis, in combination with a reciprocating rotary motion on its axis, when this latter motion is governed by the twisted plane of the cutter, or any thing essentially the same, to enable the grinder to give the required level to the ground face, and the proper line to the edge, substantially in the manner herein described."

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37. For improvements in the *Spark Arrester;* William C. Grimes, Philadelphia, Pennsylvania, September 23.

Claim.—"What I claim as new, and as constituting my invention, and desire to secure by letters patent, is the forming or dividing of the upper part of the chimney into two or more curved and divergent branches or flues, with the inner walls of each formed in part or wholly of perforated sheet iron, upon the principle and for the purpose hereinbefore set forth.

"I also claim the combination of the tubes or radial branches with the exterior case or jacket, forming as it does a chamber around and below them."

The object of making the two curved branches with the inner walls perforated, and the outer walls imperforated, is that the centrifugal action shall force the sparks against the outside, whilst the gases can escape through the perforations of the inner walls.

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38. For improvements in the machine for *Cutting Laths;* Samuel Cheney, Cleveland, Ohio, September 27.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is first, the combination of the griping bars, bent levers, and inclined planes, for griping the block for cutting the lath, as herein set forth.

"Second, the combination of the 'self-clearers' with the rest and knife, as herein described.

"Third, the counting apparatus, constructed substantially as herein described, in combination with the lath-cutting machine."

The block is griped previous to each cut by means of a griping bar which is forced down by wedges or inclined planes on the slide of the cutter, acting on bent levers, jointed to the griping bar. So soon as

the lath is cut, it is liberated and forced out into recesses formed by arms on a shaft which is slowly turned by a ratchet, operated by the slide of the cutter so as to discharge the laths after a given quantity has been cut.

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39. For an improved method of *Heating Dining Tables;* H. L. B. Lewis, New York City, New York, September 27.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the particular manner of constructing the dining table to be heated with pure hot air, introduced by means of pipes from a furnace as above described."

The hot air from a furnace passes through a chamber extending the whole length of the table and formed by the top which is of wood perforated with numerous holes and covered with sheet metal, and wooden bottom and sides. The circulation of heated air will heat the dishes, plates, &c.

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40. For an improvement in the method of *making Continuous Percussion Primers for Fire Arms, and in the Lock therefor;* Edward Maynard, Washington, District of Columbia, September 27.

Claim.—"And, having thus fully explained the character of my invention, the essential modes of application, and the manner of making and using the same, what I claim as my invention, and as distinguished from all other things before known, is—first, making primers of fulminating mixtures, or such compounds as ignite by percussion, in a continuous series, each primer, or any two or greater number, being separated from the others by a substance which is less combustible than the fulminating mixture, by which one or more may be exploded without communicating fire to the others.

"Secondly, the mode described of moving and measuring out the primers, by the movement of the lock, substantially as described."

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41. For an improvement in the *Straw Cutter;* Grey Utley, Chapel Hill, North Carolina, September 27.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the before described construction of the knife; that is to say, making it with a series of sharp cutting edges, commencing near the top of the blade, on each side, and gradually downward and inward towards the centre, forming a serrated concave edge on both sides, each cutting edge being made in horizontal and parallel lines, the lower point being made sharp, so as to pierce the article to be cut first, and each succeeding knife following in its turn and cutting the article."

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42. For an improvement in the *Æolian Attachment for Pianos;* Charles Horst, New Orleans, Louisiana, September 27.

This is for so arranging the reeds as to admit of tuning them by simply turning a screw.

Claim.—"What I claim as my invention and desire to secure by letters patent, is the confining the thin metallic reed used in the above named instruments, to a sliding plate, and securing the said metallic reed and sliding plate in a case, so that the pitch of the reed may be raised or lowered by the turning of a screw attached to the sliding plate, substantially in the manner and for the purpose herein described and set forth."

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43. For an improvement in the *Saw Mill for Sawing Lumber in Curves;* Frederick W. Harris, Lancaster, Massachusetts, September 27.

Claim.—"Having thus described my invention, I shall claim the above mode of guiding the saws, the same being effected by the curved slots of the pattern plates and blocks through which the saw works, in combination with vibrating arms applied to the saw frame and saw, as set forth, the whole being substantially as hereinbefore explained."

The saw is connected with arms, to admit of its turning to follow the curves of the grooves in the patterns, in which it moves up and down.

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44. For an improved mode of *Tuning the Reeds used in the Æolian Attachment to Pianos;* Martin and Nicholas Schneider, New Orleans, Louisiana, September 27.

Claim.—"What we claim as our invention, and desire to secure by letters patent, is the method above described, of tuning the tongues or reeds of accordeons or seraphinas, and other instruments deriving their tones from the vibration of metallic reeds, by means of movable clamps, which gripe the reeds, and embrace a part of the plate to which the reeds are attached, and admit of sliding or moving to increase or decrease the length of the vibrating part of the reed, and thus regulate the tone, as herein described."

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45. For an improved *Platform for taking off, and putting on, the wheels of Locomotive Steam Engines;* Thomas D. Simpson, Norwich, Connecticut, September 27.

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the method of removing and putting in the driving and truck-wheels of locomotive and other railroad carriages, by the employment of a vertically moving platform for letting down and raising up the wheels, in combination with the permanent railway and trussel, or other support for the locomotive or car frame, substantially as herein described."

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46. For an improvement in *Stoves;* James Pedder, Philadelphia, Pennsylvania, September 27.

Claim.—"I do not claim simply the employment of a reverberator

in a stove or fire-place, as this has heretofore been done, but for a different purpose and in a different manner; and therefore, what I claim as my improvement and desire to secure by letters patent, is the combination of a flanch or 'reverberator' with the hood or muzzle of a stove, under the eduction pipe or aperture, and projecting in front thereof, and inclining downwards, whether of a greater or less width, or set at a greater or less angle, substantially in the manner and for the purpose set forth."

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47. For an improvement in the method of *Driving Spindles, Flyers, or Bobbins, of Spinning Machines;* William Baxter, Paterson, New Jersey, September 27.

The patentee says:—"No part of the operation of spinning has been attended with so much difficulty as that of driving the flyer or bobbin, on account of the great velocities required and the delicate texture of the fibres under operation, for high velocities tend to produce variations in the rotating body, particularly if not made perfectly true, which break the threads and thus retard the operation, and render the spinning of fine threads impracticable. Cog wheels have long since been considered inapplicable to the driving of spindles or bobbins under high velocities, and belts applied as heretofore, tend, by the necessary strain required to prevent slipping, to increase, nay, to produce unsteadiness of motion and much friction, and consequent wear of the parts, soon resulting in unsteadiness of motion and in a waste of power. Efforts have been made to overcome these great practical difficulties by resting the edge of the bobbin or warve of the spindle on the periphery of a wheel, or on a round belt; but when thus driven, great velocities tend to lift or throw up the bobbin or spindle, there being no provision for preventing so injurious an effect. The object of my invention is to remove all these difficulties, by means of an arrangement which consists in driving bobbins or spindles by a belt, which is embraced by two flanches on the warve, the belt being so arranged as not to press against the periphery of the warve, but merely to hold the bobbin or spindle in suspense by the two flanches, the space between which is equal to the width of the belt, to prevent any vertical movement."

Claim.—"I do not claim as my invention making the warves of spindles, flyers, or tubes for carrying bobbins or spools, with flanches, nor the driving of them by a belt; nor do I claim driving spindles, flyers, bobbins, or spools, &c., by resting them on a belt, as all these devices and methods have been known and used before, but not as I have applied them; and, therefore, what I claim as my invention and desire to secure by letters patent, is driving spindles, flyers, bobbins, or spools, &c., by means of a belt with parallel edges equal (or nearly so) in width to the space between the flanches of the warves, and passing between them, when these warves are so arranged as to be suspended thereon, without the belt bearing against their peripheries, for the purpose and in the manner substantially as herein described."

48. For an improvement in the *Machine for Cutting Grain;* Ferdinand Woodward, Upper Freehold, New Jersey, September 27.

Claim.—"What I claim as my invention and desire to secure by letters patent, is the combination of a sheaf box with the platform into which the grain is thrown before being deposited upon the ground from the platform."

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49. For improvements in the *Spark Arrester;* William Duff, Baltimore, Maryland, September 27.

"The nature of my invention consists in making the side of the perforated tubes, which surround the central tube of the chimney, and through which the smoke and other products of combustion have to pass, of imperforated sheet metal to avoid the direct action of the exhaust from carrying sparks through the perforations in the tubes, and also in making a communication between the spark arrester around the chimney and a space at the lower part of the small box made by a partition therein, which space communicates with the fire chamber by means of tubes corresponding with the flues, but below them, so that the action of the exhaust, in producing a draught through the flues, partly exhausts the tubes below the flues, and thereby tends to draw all the sparks back into the fire to be consumed, whilst at the same time, this back current tends to keep the perforated surfaces clear for the passage of the smoke, &c."

Claim.—"What I claim as my invention, and desire to secure by letters patent, is the arrrangement of the series of tubes around the chimney, with their imperforated surfaces towards the centre of the chimney, to prevent the direct action of the exhaust, &c., from forcing the sparks through the perforations, as herein described.

"I also claim the arrangement of the damper, or valve, with the inverted concave plate and cone at bottom, in combination with the series of tubes composed of perforated and imperforated surfaces.

"I also claim, in combination with the series of tubes surrounding the chimney, the tubes attached to the outer casing, or the equivalents thereof, for conducting the sparks into the receptacle, that are carried by the force of the current up to the top, as herein described.

"And, finally, I claim connecting the fire chamber with the receptacle for the sparks, made in the lower part of the smoke box, by a partition therein, by means of a lower tube or range of tubes corresponding with the flue-tubes, so as to carry back the sparks to the fire chamber by an arrangement entirely within the casing of the boiler and furnace, and acted upon by the current, as herein described."

List of American Patents which issued in the month of March, 1842,—*with Exemplifications, by* CHARLES M. KELLER, *late Chief Examiner in the United States Patent Office.*

Continued from page 118.

15. For improvements in the *Springs of Railroad Cars;* Joseph F. Talson, Jersey City, N. J., March 18.

Three or more helical springs are arranged one within another, and placed within a cylinder, so as to be compressed between one of the heads of the cylinder and a piston working therein, and interposed between the wheel, axles and frame, or between the frame of the truck and bearing bars that rest on the boxes in which work the journals of the axles.

Claim.—"I do not claim to have invented any of the parts described and employed in this arrangement when taken individually; but I do claim as new and of my own invention, and desire to secure by letters patent, the combination of a plurality, say of three or more, spiral springs, with a piston within a cylinder, the convolutions of such springs being alternately right and left handed; this combination of springs being applied in the manner set forth, or, for example, between the frame and bearing bar, for the purposes hereinbefore made known; the whole being constructed and arranged as described herein."

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16. For an improvement in the *Scraper for excavating Earth;* John Branson, Jr., Sangamond county, Illinois, March 18.

A curved plate of iron, having the lower edge made sharp, is secured to a standard, running down from a beam, and braced to the beam by two diagonal (iron) braces, (rods,) that extend from near the ends of the plate to the beam.

Claim.—"I do not claim as my invention the scraper plate, nor the frame, consisting of the handles, beam, &c., as these have been known before, when used separately. But what I do claim as my invention, and desire to secure by letters patent, is the attaching of a scraper plate formed in the manner herein described, to a beam and handle, by means of the upright and iron rods, so that the upper edge of the plate shall be at right angles to the beam, and shall not be permitted to turn as in the scrapers generally used."

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17. For improvements in the *Knitting Loom;* Arasmus French, Springfield, Mass., March 18.

These improvements are on that class of knitting machines in which the fabric is formed, one stitch or loop at a time, on a series of needles, projecting from a belt that passes around rollers. The first claim relates to the mode of making the chain or belt by a series of hinge joint links, one joint for each needle, so that the number of needles can be increased or decreased by simply taking out or inserting a joint pin for each needle that is renewed or added. The second claim relates to the mode of making the nippers of two springs, by which the thread or yarn is conveyed from the bobbin to the needles. The third claim relates to an arrangement of parts by which the action of the nippers is reversed, to reverse the direction of the knitting. And the last claim relates to an arrangement for retaining the chain of needles on the roller around which it passes by a lip above and a spring below.

We are under the necessity of omitting the claims, as they refer to,

and are wholly dependent on, the drawings; but we have above given the substance of them.

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18. For an improvement in *Friction Matches;* Stephen Blaisdale, Brunswick, Cumberland county, Maine, March 18.

Claim.—"What I claim as my invention, and which I desire to secure by letters patent, is the manufacture of friction matches by dipping the matches into a compound of sulphur and phosphorus, formed into a paste or fluid, by means of glue or any other glutinous or viscid substance as herein set forth."

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19. For improvements in the *Steam Engine;* Joseph J. Parker, Plymouth, Washington county, Ohio, March 18.

The reader will be able fully to understand the improvements for which this patent is granted, by referring to the following

Claim.—"What I claim as my invention, and which I desire to secure by letters patent, is the mode of combining the sliding valves and steam chamber, the former being so arranged that when driven out they shall form heads for the steam to act against in operating the pistons, and also the mode of combining the valves of the two chambers by means of the chain and segment described, so that when one is forced out by the steam, the opposite valve shall be pressed in, as herein set forth."

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20. For an improvement in the *Spark Arrester;* John V. L. Hoagland, Jersey City, N. J., March 18.

The patentee says:—"The nature of my invention consists in carrying my funnel or chimney up through the outside casing, and giving the top of the funnel a bend or curve so as to arrest the sparks in their course, and direct them downwards to the bottom, by means of the concentric casing being of a semi-circular form, attached to the front of the outside casing, and concentric with the bend or curve of the top of the chimney or funnel."

Claim.—"What I claim as my invention and desire to secure by letters patent, is the combination of the curved top of the funnel with the concentric casing placed in that or any other part of the chimney or funnel, which constitutes the whole of my claim, as is fully shown and set forth in the drawings and specification."

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21. For an improvement in *Ships' Anchors;* Wm. H. Porter of England, assigned to John Jenks Osborne, New York City, New York, March 18.

The two arms are made in one piece and jointed to the end of the shank, so as to turn thereon, the object of which is to prevent fouling the cable, and to prevent one of the flukes from projecting so high as to injure the bottom of the ship, for when one fluke is in the mud or sand the other will lie on the shank. Each arm is provided with a projection or second fluke on the outside, about mid-way between the point of the main fluke and the junction of the arms with the shank.

Claim.—"I would remark that I am aware that anchors have been before made with arms capable of movement on the shank or stem, I do not, therefore, claim the same generally; but what I do claim as my invention and desire to secure by letters patent, is the method of constructing the arms and flukes of the anchor with the projections, for the purpose and in the manner described."

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22. For a *Composition of Matter for covering Ships' bottoms;* Samuel Williams, New York City, New York, March 18.

The patentee says:—"The materials are varnish, boiled oil, arsenic, red lead, sulphur, and sugar of lead, to which may be added any ochre or other coloring substance, according to the fancy of the person using the same. The proportionate quantity of each material is as follows:

Half a gallon of varnish.
One quart of boiled oil.
Two pounds of arsenic.
Two pounds of red lead.
Half a pound of sulphur.
Half a pound of sugar of lead.

"To which may be added, if a copper color is required, one pound of yellow ochre, and a small quantity of lamp black. These several quantities of ingredients will make about a gallon of the composition. This composition is applied to the vessel while it is boiling hot, and with brushes, in the same manner as ordinary painting."

Claim.—"What I claim as my invention, and desire to secure by letters patent of the United States, is the peculiar admixture of materials in the manufacture of paint, or composition of matter, for covering the bottoms of ships and other vessels, in the manner and for the purposes above described in this specification."

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23. For improvements in the *Cooking Stove;* Thos. O. Sayre, Elizabethtown, New Jersey, March 23.

Claim.—"Having thus fully described the construction of my improved semi-circular cooking stove, and explained the manner in which the same operates, what I claim therein as new and desire to secure by letters patent, is

"First, The manner of arranging and combining the semi-circular oven-space with the semi-circular chamber of combustion and with the quadrant shelves, or carriages, and the circular ways by which they are guided and kept in place.

"Secondly, I claim the particular manner of forming the lining of the back of the semi-circular fire chamber, in part with fire-brick, and in part with pieces of cast-iron, in the forms here designated, so that they shall interlock, and under the arrangement specified, by means of which the heat of the oven-space will be rendered uniform, and its temperature such as to insure its perfect action.

"Thirdly, I claim the manner of constructing the combined swinging door and horizontal swinging semi-circular grate, arranged and

operating substantially as herein set forth; and these parts and combinations I claim, whether made precisely in the form herein designated, or under such variations thereof as may be dictated by fancy or by convenience, whilst the construction, arrangement and operation thereof remain substantially the same as herein set forth and made known."

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24. For an improvement in *Tailors' Shears;* Thomas Hawkins, assigned to James G. Wilson, New York, March 23.

The patentee says:—"The nature of my invention consists in allowing the under blade and bow of the shears to remain stationary, and having a sling joint connexion between the upper blade and bow; so that by raising the upper bow, the upper blade is thereby raised, and in depressing the upper bow, the upper blade is thereby brought down by means of a proper purchase formed by the stirrup connecting the sling joint, and made to cut upon the stationary under blade."

Claim.—"What I claim as my invention and desire to secure by letters patent, is the application to shears of the sling joint connexion, or any similar mode producing the same result, by which the upper blade is moved by the upper bow, and allows the under blade and bow to remain stationary, as herein described, using therefor any material which will answer the purpose."

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25. For an improvement in *Tailors' Shears;* Herman Wendt, New York City, New York, March 23.

A volute spring is introduced in the joint for the purpose of forcing and keeping the shears open, so that the operator has only to close them, by having one end of the spring attached to the joint pin, and the other to one of the blades. And to the forward part of the under side of the bow of the upper blade, there is a curved lip in which the fore finger rests, to give a greater purchase.

Claim.—"What I claim as my invention and desire to secure by letters patent, is the addition of the concave curvilinear lip to the finger bow or handle, and the application of the spiral spring in the joint, the whole constructed, combined and operating substantially as above set forth."

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26. For a *Subterrane Bomb, or Shell;* James MacGregor, Jr., Wilton, Saratoga county, New York, March 23.

The patentee says:—"The nature of my invention consists in forming bombs or shells of cast-iron, which are to be charged in the manner of other bombs or shells, with gunpowder and such other matter or things as are used in the charging of such instruments, and providing such bombs or shells with a lock so arranged that they shall be discharged by the tramping of men, horses, or the passing of carriages over them; and in placing them under the surface of the ground where the troops or baggage of an army is expected to pass."

Claim.—"Having thus fully described the nature of my invention,

and shown how the same is to be carried into effect, what I claim therein, and desire to secure by letters patent, is having the powder for a mine confined in a cast-iron shell or case, and of constructing and combining thereto a lock that will operate by the passing of men, horses, or wagons over it, as above set forth; not, however intending to limit myself by this claim to the precise form of lock therein set forth, but to vary the same as I may think proper, while the same end is attained by means substantially the same."

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27. For improvements in *Cooking Stoves;* Jordan L. Mott, New York City, New York, March 23.

The bottom of the oven is composed of the upper surface of three horizontal tubes, the middle one larger than the other two. The products of combustion pass from the fire chamber over the oven down two side flues at the back, into the two side tubes at the bottom, then in a flue space at the front end of these tubes, thence back through the middle tube, and up the middle back flue to the chimney. These horizontal flue tubes are cast together, with a connecting plate at each end, which form, by appropriate flanches, the connexions with the several flue spaces, so that they can be readily removed for cleaning.

Claim.—"Having thus fully described the nature of my improved tubular oven cooking stove, and shown the manner in which I connect and combine the several parts thereof, what I claim therein as new and desire to secure by letters patent is, first, the combining, in the manner set forth, of two, three, or more tubes, which constitute the lower oven flue or flues, with the flue or boiler space over the oven, with the descending and ascending flues at the back of the oven, and with the flue space into which the fore ends of said oven flues open.

"I claim also the manner of arranging and combining the lower oven flues together, by means of the end pieces and collars, so as to render them removable at pleasure, for the purpose of cleaning or repairing them. And I do not intend to limit myself to any particular form or construction of the stove, or cooking apparatus, in which I apply my tubular flues to constitute the lower part of the oven, but I claim the using or combining them, substantially in the manner set forth, with any kind of cooking stove, cabouse, or range which is furnished with an oven or ovens, and in which they can be conveniently employed."

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28. For an improvement in *Over Shoes;* Daniel Hodgman, New York City, New York, March 23.

This is for inserting a metal plate in the heel part of the over shoe, that carries a nut, through which passes a pointed thumb screw, by which the over shoe is secured to the heel of the boot.

Claim.—"What I claim as my invention and desire to secure by letters patent, is the inserting a screw into the counter of an over shoe, in the manner and for the purpose above described."

29. For a *Composition for rendering Cloth, &c., water-proof, without losing the pliability;* Nathaniel Hatch, Eastport, Washington county, Maine, March 23.

The following is extracted from the specification, viz:—"Take half a pound of gum shellac, and one pint alcohol, and put them in a tin kettle with a cover, and suspend the kettle with said contents in a boiler of boiling water, and keep the heat up till the gum dissolves, then put one quart of boiled linseed oil in the kettle with the shellac, and boil them together till they are well mixed. Secondly, take one ounce of India rubber, cut it in very small pieces, and one quart of spirits of turpentine, and put them in another tin kettle with a cover, as before named, and suspend it, with the contents, in a boiler of boiling water, and keep the heat up till it is dissolved; then put two quarts of boiled linseed oil in the kettle with the rubber, and keep the heat up till they are completely mixed. Thirdly, take one pound of yellow hard soap, and two quarts of water, and boil them together till the soap is all dissolved.

"Then to make the composition, take 8 lbs. white lead ground in oil, 1 gill coal tar, 6 ounces lamp black, 1 lb. gold litharge, 4 quarts boiled linseed oil, 3 quarts of the above named solution of India rubber, 1 gill of the solution of shellac, as above named, 1 pint of copal varnish, and mix them all well together. Then put one quart of the soap and water in the composition while the soap and water are boiling hot, and stir them together till the whole is completely mixed together, and then apply the composition to the cloth with a common paint brush, and when the cloth is nearly dry, so that it will not rub off, apply the second coat of the composition, and when the second coat is nearly dry, apply the third coat of the composition, which makes the cloth water-proof and pliable. If I want to make any other color, I put other colored paint in, enough to make such a color as I want, namely—to make yellow, I take chrome yellow; or for green, I take chrome green; and to make white, I leave out the lamp black, &c."

Claim.—"I claim as my invention, the compounding of the several articles as mentioned above, and in their several proportions there described, for the formation of a composition which, when put on cotton or linen cloth, renders it water-proof without losing its pliability."

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30. For an improved *Doubled-flued Stove or Grate;* David Petree, Little Falls, New York, March 23.

The patentee says:—"The nature of my invention consists in providing and locating a flue just at the top of the coal or wood grate, and a gas-blower or cover to the grate swinging from the top of that flue, so as to rapidly ignite the coal, and effectually to carry off deleterious gas, so that none of it shall escape into the room, by means of which improvement, any description of combustible material may be used without any unhealthy or unpleasant effect whatever. In addition to that advantage, this stove possesses the virtue of affording a very large degree of heat from a comparatively small quantity of fuel,

also of producing a quick as well as durable fire from a given quantity of fuel."

Claim.—"What I claim as constituting my invention in the within described double-flued stove, is the manner in which I have combined the movable cover with the grate and with the damper, for the purpose of allowing a fire to be kindled below said cover, and thus preventing the escape of gas from the fire into the room; the whole apparatus being constructed and arranged substantially as set forth and described."

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31. For an improvement in the *Windlass;* William Holmes, Baltimore, Md., March 23.

We are under the necessity of omitting the claim, as it refers to, and is dependent on the drawings. It is limited to a peculiar manner of constructing the parts by which brake-levers are applied to the windlass.

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32. For an improvement in the *Propeller for Ships;* Daniel Rudd, Bozrah, New London county, Connecticut, March 23.

A series of blades are jointed together, (and for a short distance slide into each other,) and to a series of cranks—there being one crank for each joint, and on the crank-shafts there are segment wheels connected together by cords, or chains, by means of which the cranks receive a reciprocating, vibratory motion, in opposite directions, which communicates to the series of blades a continuous sculling motion.

Claim.—"What I claim as my invention and desire to secure by letters patent, is the continuous jointed scull, moved by the cranks, &c., combined and arranged in the manner and for the purpose herein described."

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33. For an improvement in the *Bridle for Horses;* John C. Smith, Brookhaven, New York, March 23.

Claim.—"What I claim as my invention and desire to secure by letters patent, is attaching the lower ends of the reins to the martingale strap, or other secure part of the harness, near the fore part of the animal, and passing the other ends over pullies attached to the rings of the bit, in the manner set forth, or in any other mode substantially the same."

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34. For an improved method of *Spinning*, by which a thread is spun of one kind of material and covered with another; Moses Chase, Baltimore, Maryland, March 23.

A thread, say of cotton, is received from a bobbin and passed between two rollers that receive a thin sliver of wool from a carding machine, and from these rollers the thread is carried to a flyer, the rotation of which winds and spins the woolen sliver on to and covering the cotton thread.

The claim, which we are under the necessity of omitting, is limited

to the arrangement of the carding engine, with a series of flyers, to produce this result.

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35. For an improvement in the *Ditching Machine;* C. R. Bartlett, Genesee, Illinois, March 23.

Without drawings to illustrate this improvement, the claim could not be understood ; it relates to an arrangement of the cutters for forming the bottom and sides of the ditch, and the angular trough which carries up the earth to form the embankment.

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36. For an improvement in the *Machine for Cleaning Grain ;* J. N. Bird & E. D. Weld, Trenton, New Jersey, March 28.

This improvement consists in passing the upper end of the shaft (designated in the claim by the letter K) of the beating cylinder through the hub of the fan blower, placed above and operated by a separate pulley, so that the cylinder beater and the fan can be turned in opposite directions.

Claim.—"What we claim as our invention and which we desire to secure by letters patent, consists in the mode of combining the fan on the upper end of the revolving cylinder with said cylinder, viz: by constructing it with a hollow axle, through which the shaft (K) passes, and providing it with a separate pulley, arranged immediately below the pulley, for driving the aforesaid cylinder, by means of which arrangement, a greater velocity, and in a contrary direction may be given to the fan than if fixed permanently on the shaft (K,) as heretofore, or allowing, if necessary, by means of a broad band, of their being driven together in the same direction, all as herein set forth."

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37. For an improvement in the *Lamp for burning Camphine and other essential oils;* Charles Carr, Philadelphia, Pennsylvania, March 28.

Claim.—"Having thus described the nature of my improvement in the lamp for burning spirits of turpentine, camphine, and other essential oils, what I claim therein as new and desire to secure by letters patent, is the manner in which I have constructed, arranged, and combined the rack and pinion, the wire, the wick holder and the burner, so that the outer tube of the burner shall be continuous at its upper end, whilst the wick holder shall have the requisite play up and down, not only for the purpose of combustion, but also for the supply of new wick, when requisite, said wick holder being permanently retained within the burner; the respective parts being constructed and operating substantially as described."

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38. For an improvement in the *Plough for Prairie Lands ;* Cromwell K. Bartlett, Geneseo, Henry county, Illinois, March 28.

Claim.—"Having thus fully described the manner in which I construct and use my prairie plough, what I claim as my invention and desire to secure by letters patent is the forming of the main body of

the wood work thereof of a plank which is to run on the ground, in the manner herein set forth, and having combined with it a share, coulter, mould-board, and landside, the operating parts of which extend below the bottom of the plank to the depth of the intended furrow. I claim the forming of the share, coulter, and landside of one continuous piece of metal, but at right angles, in the manner and for the purpose herein fully made known. I claim the manner of combining and arranging the timber and the share, coulter and mould-board of the plough so as to constitute one piece by their combination with each other, which combined piece may be adjusted so as to regulate the depth of the furrow by means of screws and nuts, or other devices, substantially the same with that described."

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39. For an improvement in the *Argand Lamp;* Daniel Pettibone, Philadelphia, Pennsylvania, March 28.

Claim.—"The invention claimed and desired to be secured by letters patent, is constructing the lamp with a middle revolving cylinder, ribbed on its inside and contracted at top, with a shoulder and ring for turning said cylinder, in combination with the spiral thread on the surface of the inner cylinder, over which the wick is placed for raising or lowering the wick as herein set forth."

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40. For an improvement in the mode of applying the *Elastic Force of Steam, Gas, &c.;* Henry Pratt, of Great Britain, but now residing in the United States, March 28.

Claim.—"Having thus fully described the nature of the apparatus used by me for applying the elastic power of steam, or of gases, or of the pressure of a column of water to the propelling of machinery, and having likewise set forth the manner in which I construct my condenser when steam is employed, what I claim as new therein and desire to secure by letters patent, is the forming of one, two, or more helical passages within the periphery of a cylindrical revolving body which passages are to ascend gradually from the lower to the upper part of said body, and said passages having one of their sides formed into steps or offsets in the manner set forth, for the producing of a powerful friction and resistance to the passage of a fluid through them, in the manner and for the purpose set forth. I also claim the reversing of the direction of these channels just before the fluid escapes therefrom. I claim also the within described manner of constructing and arranging the respective parts of my cold air condenser, said condenser consisting of a series of conical frustrums of sheet metal placed within a vertical metallic case; said conical frustrums being formed and operating in the manner set forth and being combined with the lower vessel substantially in the manner described. I also claim the coating or covering of the exterior of the several conical frustrums and other parts as described for the purpose of increasing the surface upon which the air may operate. I have spoken of the revolving body in my power machine as placed vertically, but it

may be placed horizontally, or the operating fluid may descend instead of ascending through the convoluted channels, and other variations may be made in matters of detail. I do not therefore intend to limit myself to the precise form and arrangement herein given, but to vary these as I may think proper, whilst the principle and the effects produced remain substantially the same."

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41. For an improvement in the *Thumb Latch;* Edmund Parker, Meriden, Connecticut, March 28.

The opening in the handle plate through which the thumb latch passes is enlarged diagonally so that the thumb piece can be introduced, and when introduced turned to occupy its proper place, with an enlargement within and without to avoid the necessity of a fulcrum pin—the diagonal enlargement being sufficiently large to admit the shoulder which retains the thumb piece when turned in a vertical position.

Claim.—"What I claim as constituting my improvements in the thumb latch is, first, the forming of the opening in the plate in a direction standing at an angle with the opening and of such length as to allow the shank of the thumb piece to pass entirely through it, and in adapting these parts to each other, in the manner set forth, so that by rotating the thumb piece it will be made to occupy the part of said opening."

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42. For an improved *Apparatus to be used in Copying Statuary, &c.;* Henry Dexter, Boston, Massachusetts, March 28.

The statue to be copied is placed upon a turning platform graduated on its periphery and the block to be cut is placed upon a like platform, and by the side of each platform there is a vertical graduated rod having a slide through which passes a graduated pointer—by means of these the sculptor or carver can take the most accurate measurements.

We are under the necessity of omitting the claims as they could not be understood without the drawings.

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43. For an improvement in *Light Houses;* Aaron Folger, Nantucket, Massachusetts, March 28.

This is for arranging the lamps and reflectors all around, and so near to the glass of the lantern as to heat it by radiation, and thus prevent frost or condensation of vapor on the glass.

Claim.—"What I claim is the following, viz: the position of the lamps in such contiguity to the glass of the lantern as will keep a temperature to that effect; this may be done by placing them on any proper line of distance between the glass and six inches of the glass, as the size and shape of the lamp and reflectors may require, the distance from the glass being mostly governed by the size and shape of the reflectors and in the manner described in the specification or any other manner that is substantially the same."

44. For an improvement in the *Galvanic Battery;* Patrick Coad, Philadelphia, Pennsylvania, March 28.

Claim.—"What I claim as my invention and which I desire to secure by letters patent, are the modes of depression and elevation of the galvanic battery and the graduation of said battery and galvanic trough, so that the intensity of the effect produced may be varied. I do not claim to be the inventor of the metallic cylinders, or the screws by which the wires are attached to said cylinders, neither do I claim to be the inventor of the glass handles with the metallic screws partly through, but I do claim as my invention the attaching of the glass handles to the metallic cylinders in the manner and for the purposes specified."

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45. For an improvement in *Daguerreotype Impressions;* B. R. Stevens & S. Morse, Lowell, Massachusetts, March 28.

The patentees say:—The nature of our invention consists in preparing the metallic plates on which daguerreotype impressions are to be taken so as to fix the impressions on the plates and adapting them to the reception of colors by coating the same with varnish or solutions of gum.

Claim.—"What we claim as our invention and desire to secure by letters patent is the mode of preparing daguerreotype impressions so as to fix them on the plate, and adapting them to the reception of paints and colors by coating the same with varnish or solutions of gums; using for the purpose of coating said plates, any kind of varnish or gum, or any preparation of varnish or gums, which will produce the intended effect."

MECHANICS, PHYSICS, AND CHEMISTRY.

Description of an Automatic Dividing Machine, arranged for use in the Coast Survey Office, by Joseph Saxton, *Assistant in the office of Weights and Measures, Washington, and constructed by William Würdeman, mechanician, Coast Survey Office.*

(With an engraving.)

The dividing machine, which has been rendered automatic by Mr. Saxton, was imported for use in the Coast Survey office by the late F. R. Hassler, Esq., superintendent. The graduations made by means of it by different persons were unsatisfactory. Many causes were assignable for this, and it was considered by the present superintendent, Professor A. D. Bache, desirable that the most obvious of the causes of error should be got rid of, by rendering the machine automatic, before the minor causes of irregularity were sought for. This was done by Mr. Saxton, in the manner described in the following pages. The result has been very successful, not only in its first application, but in permitting the determination and removal of sources of error, previ-

ously concealed in the working of the machine. The drawings of the proposed additions upon a scale necessary for working were made by Mr. Saxton, and the work was executed by Mr. William Würdeman and his assistant mechanicians in the Coast Survey office. Accuracy, beauty of finish, ease of reading, economy of time and labor in dividing, have all been gained by the improvements.

The machinery for rendering the dividing machine automatic, consists of a brass wheel A, about 20 inches in diameter, mounted on the axis B, (fig. 1, Plate IV.) One of the arms of the wheel A, has a slit extending from near the centre of the rim; in this slit is fixed the crank-pin so that it can be placed at any required distance from the centre. On the edge of the wheel is turned a groove in which runs a cord for driving the wheel. On the other end of the axis is fixed the wheel C, which is geared into the wheel D, on the lower end of the vertical shaft E, (fig. 2.) On the upper end of the same shaft, is another wheel, F, geared into the wheel G, on the horizontal shaft H. On the end of the shaft H is a wheel I, which gears into the wheel J, on the axis K. The wheels C, D, F, G, I and J are all bevel wheels, having the same number of teeth, (60,) and work into each other at right angles.

The shaft E has on it a sliding joint L, for altering its length; the shaft H is turned and ground of uniform thickness, so that it may slide accurately through the socket of the wheel G, and also through its bearing at M, in which it turns. The axis K has on it two eccentrics, N and O. N to raise the tracing point, and O to move it horizontally. One half of the circumference of N is concentric with the axis on which it turns, so as to keep the point up while the crank-wheel moves half a revolution, and is moving the dividing plate. The other is eccentric to the axis about $\frac{1}{10}$th of an inch, so as to let the point rest on the circle while it is making the division. The eccentric O has about $\frac{1}{3}$ of its circumference concentric to the axis; the rest is described from a point about $\frac{1}{3}$ of an inch from the centre. N and O must be fixed on the axis with regard to each other, so that N will raise the point before O begins to move it back, and both with regard to the crank-wheel A, so that the point will be raised before the crank begins to move the dividing plate, and keep it up until it is done moving, and O has moved the point back, and then let it down before O begins to let it return. The axis K has also on it, near the end, a small cog P, to shift the ratchet-wheel Q one tooth every revolution of K. The ratchet-wheel has 60 teeth, and is kept in its proper position by the detent spring R. In front of the wheel, and fastened to it by two screws, is a circular plate S, (figs. 1 and 3,) with 20 notches in its edge, the deepest one for the longest line, or 5°; the next for 30′; and the shallowest for 15′; and the edge of the plate for the 5′ lines.

The segment T, (figs. 1 and 3,) is fixed on the vertical part of the tracing frame U, and has a pin in the end, at V, of such a size that it can drop into the notches in S, as they are brought under it by the revolutions of the ratchet-wheel, and so regulate the length of the division lines. The time of raising the ratchet must be when the stop pin is raised out of the notch by the motion of the traces back-

wards. To give motion to the screw, a stout fusee chain is used, $\frac{1}{8}$ of an inch broad, and $\frac{1}{14}$ of an inch thick, which answers well; one end is attached to the ratchet-barrel W, round which it is wound five or six turns, the other end is attached to the crank pin X. Near the lower end of the chain, at Y, is a small tube, containing a strong spiral spring, arranged like the common spring weighing machine, but having a motion of only about $\frac{1}{8}$ of an inch; the spring must be so strong as not to give by the force required to turn the screw, but only to give a little when the ratchet comes up to the stop, and the crank is just passing the lower centre. Between the spring and the crank-pin is an arrangement for lengthening or shortening the chain when it is arranged for making a larger or smaller division; for this purpose, two pieces of brass wire, about six inches long, having a screw cut on them their whole length, and each filed away one-half, and two small milled nuts, tapped with the same thread, are run on each; the two wires are laid together, and the nuts screwed up until they embrace both wires, as shown at Z, (fig. 1.)

The crank-pin is fixed on a slide projecting beyond the nut which fastens it, so that it may be extended, if necessary, beyond the circumference of the wheel, or by reversing, it may be brought quite to the centre; when the divisions are to have the long end towards the centre, a jointed lever, as shown at *a*, (fig. 3,) is used, it is screwed fast to the cross bar *b*, (figs. 2 and 3,) directly over the eccentric O, and connected to the vertical frame U at *c*, and the stop pin V is shifted to the other end of T, and the abutting piece *f*, on U, is to be removed, when the eccentric O will act against the lever *a*, at *d*, and move the point in an opposite direction. The tracing-frame is made to follow the eccentric by a weight and cord passing over a pulley and hooked to the vertical part of the tracing frame at *e*, *e*, (fig. 3.)

When the adjustment is made for dividing with the long end of the division lines, towards the circumference of the circle, all the wheels connecting the axis K with the axis B should be marked with a dot on the tooth and space in which it works, and a line should be drawn on the shafts E and H, and a corresponding mark on the sockets through which they pass, so that they may always be fastened in the same position. The axis K should have two short pins fastened on it, and notches in the ends of the sockets N and O, to fix them in their proper position when the lines are towards the circumference or centre, as the case may require. The slit in the crank-wheel A, in which the crank-pin is fastened, should also be graduated, showing the distance of the pin from the centre, for each degree, minute, and second that may be required in dividing.

By marking the position of each part of the machine in this way, much time and trouble will be saved in making the necessary changes for different kinds of dividing, whether it be in the number, or the direction in which the long lines are to be extended. The tracing point should be adjusted so as not to be raised more than about the thirtieth of an inch, or it will be liable, in descending, to make a small dot at the commencement of each line, which would injure the appearance. In the drawing, the eccentric N is represented as acting on the tail of

SAXTON'S

AUTOMATIC

DIVIDING ENGINE.

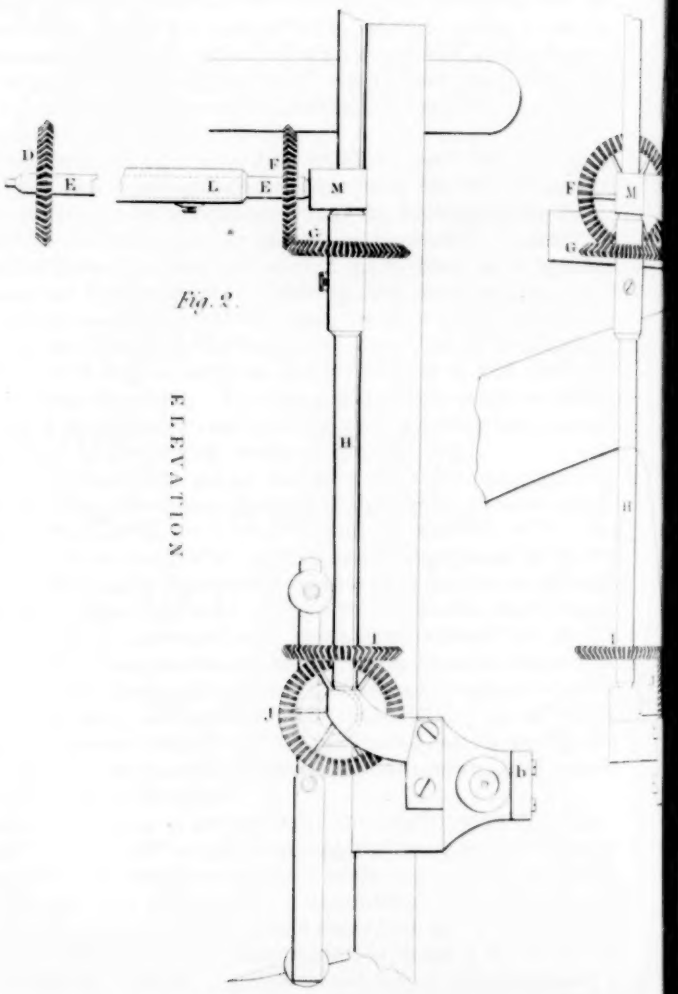


Fig. 2.

ELEVATION

Fig. 3.

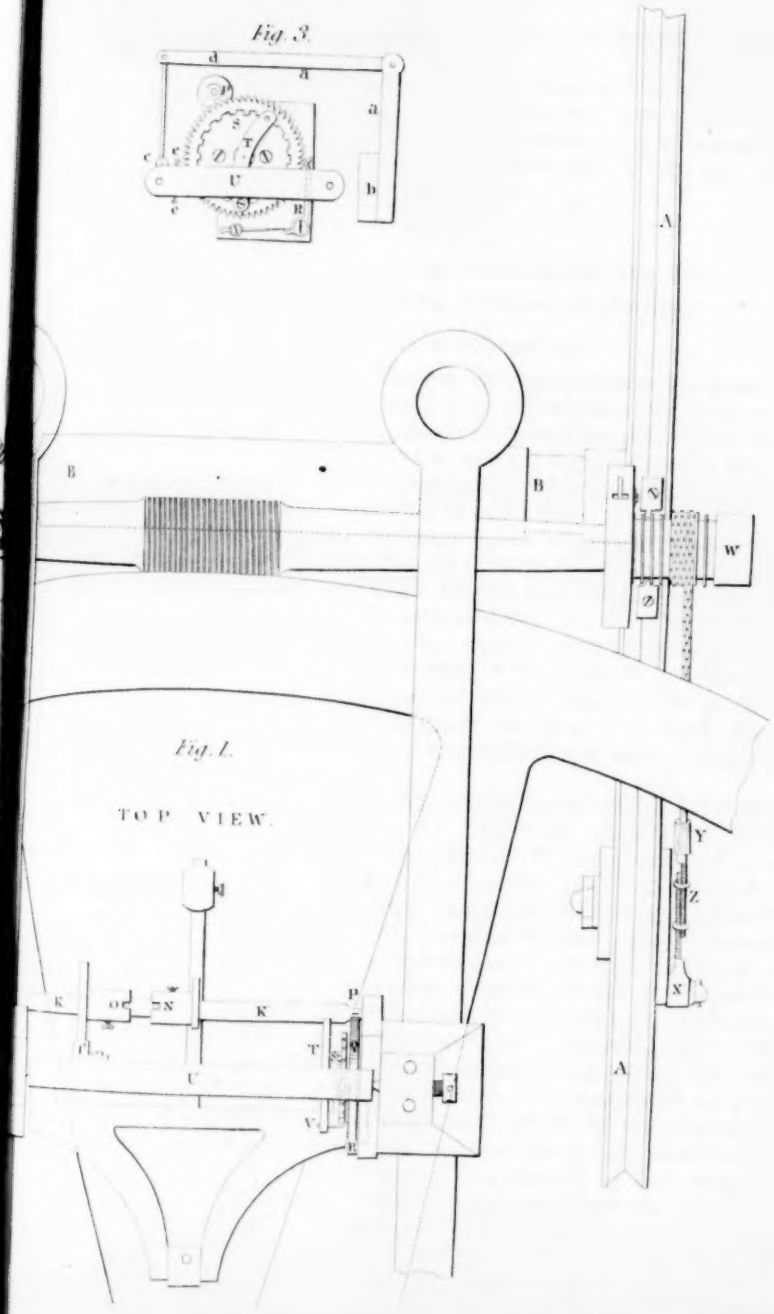


Fig. 1.

TOP VIEW.

the tracing-frame, but it is better to make it act on a steel pin in the side of the tail.

By this arrangement of the crank for turning the dividing screw, the stops of the ratchet are brought in contact when the crank is passing its centres, and the motion of the screw so slow that it is not possible for the stops to strike so hard as to do any injury, and the dividing may be done with great rapidity.

Observations on the more recent researches in the Manufacture of Iron. By Dr. J. Lawrence Smith, of Charleston, S. C.

(Continued from page 204.)

In the last article on this subject, the operations of the blast furnace alone were alluded to, and among the statements then given, was that of the composition of the gas taken from the mouth of the furnace; which gas contained about 24 per cent. of carbonic oxide, this representing a large portion of the combustible used, which is lost in most of the furnaces now in operation in this country.

M. Ebelman states that the combustion of the gas passing from the mouth of the blast furnace is equal to from $\frac{62}{100}$ to $\frac{67}{100}$ of the calorific effect of the coal used, and MM. Bunsen and Playfair set it down as $\frac{90}{100}$ which last, I am rather inclined to believe, is rather too large a fraction; they spoke of the furnace worked with bituminous coal, and Ebelman had allusion to one worked with charcoal. Without being able to decide exactly what portion of the combustible of the blast furnace is lost, it is sufficient to know that it is far greater than that consumed, to lead at once to the employment of means bringing into use this waste combustible.

The employment of heat lost from the mouth of the blast furnace, for the purposes of metallurgy, &c., has been claimed by many as having been used by them since 1834. The following are some of the claimants:—MM. Thomas and Laures, (civil engineers;) MM. d'Andela-re and de Lisa, (forge masters at Treveray;) M. le Marèchal Marmont, (in Austria;) M. Houzeau Muiren, (of Ardennes;) and M. de Faber Dufaur, (of Wasseralfingen.) All their claims of priority, however, ought to be laid aside, since the operation was performed many years prior to the time that any of them claim to have first employed the lost heat. And as a proof of this assertion, I give the following extract from the Journal des Mines, Juin, 1814.—"M. Aubertot, of the department of Cher, and owner of furnaces and other works in excellent condition and management, which he superintends personally, made, several years ago, a great many experiments to discover some means of economizing the amount of fuel used in the working of iron, either by endeavoring to introduce the operation by the catalan furnace, or otherwise. He was led to try what could be accomplished by making use of the flame which passed out of the blast and refining furnace. He first employed it for the cementation of steel, in which he succeeded perfectly; then he used it for calcining lime, also for burning bricks and tiles. Afterwards he passed it into

a reverberatory furnace, in which the temperature was raised sufficiently to heat the blooms and bars, for hammering the one and drawing the other out. Finally he succeeded in producing all the above effects at one and the same time, by causing the flame to circulate through several furnaces side by side."

In 1834, M. Houzeau Muiren took out a patent for using the waste heat from the mouth of the blast furnace, for carbonizing wood at the furnace of Bievres, (Ardennes;) in which he states that twice the quantity of charcoal is obtained by treating the wood after his method, than by the ordinary way of burning in the woods. By the heat lost from the furnace, 100 parts of wood gave 35 of charcoal, and from 40 to 45 of *charcoal roux* (half burnt wood.)

But after all, it is not to those who first applied this lost heat to economical purposes that we are indebted for the practical information that is now in our possession; for had they made their arrangements so as to exhibit an undisputed advantage arising out of its adoption, it would not have been so tardy in its progress.

It is to M. de Faber Dufaur, superintendent of the iron works at Wasseralfingen, in the kingdom of Wurtemburg, that most of the credit is due for the present method of converting pig into wrought iron, by using and burning the gases that escape from the mouth of the blast furnace. The best idea that can be given of the manner in which the operations are conducted in the above works, and the advantages accruing therefrom, is contained in the following short extract from a letter written by M. Grouvelle to M. Dumas.*

"The establishment at Wasseralfingen is supplied with ore, three-fourths of which is a hydrated oxide of iron, and the other fourth is an ore in grains. The influence of the first species of ore gave to the pig so bad a quality that it was used altogether for castings. M. Dufaur, by his processes, without altering the operations of the blast furnace, now obtains from the pig a wrought iron of superior quality.

"The first gas furnace put in operation by him was a refining furnace, into which the pig metal was run as it issued from the blast furnace, where the refining was executed with the air of the hot blast. From this the most beautiful results were obtained, and it worked regularly during the year 1837. In 1838, he erected a puddling furnace; and finally, in 1839, he completed his magnificent system for the fabrication of iron, by constructing a furnace for re-heating and welding."

At Wasseralfingen there are now turned out annually, one million pounds of wrought iron in various forms, made in these new furnaces, and owing to the deficiency of moving power, all the pig cannot be worked up. This operation of refining iron by the combustion of gas without any other fuel, has been in successful operation at the above locality for several years, and it has been followed with a great improvement in the quality of the iron, and has reduced the loss to one-fourth of what it was originally.

This method of refining the pig has also been in active operation in

* Comptes Rendus, 1841, p. 382.

a number of places, and whenever properly executed, is always attended with economy and success. M. d'Andelarre, in one of the departments of France, in a letter states, "our puddling furnaces, heated altogether by the gas lost from the mouth of the blast furnace, has been attended with the most complete success, which rarely happens in the first attempts at the application of any improvement, which most generally require long experience. We lighted up our furnace on the morning of the 5th, and put in the first charge at 11 o'clock on the morning of the 6th, and shingled the same at three-quarters past twelve. The accomplishment of the results so quickly passed our expectations, resulting in

"1st, An economy of the total amount of fuel used in the refining of iron, (which, in a furnace with two doors, amounted, in 24 hours, to 6,000 pounds bituminous coal, costing twelve dollars.)

"2d. Improvement in the quality of the iron.

"3d. The loss was very small, being 5 instead of 20 per cent., which it is by the old processes.

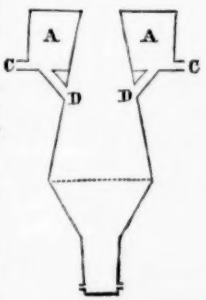
"4th. The operations of the furnaces are much improved."

Here we see that the experience of M. d'Andelarre accords exactly with that of M. Dufaur, and already have Russia, Prussia, Sweden and Germany sent commissioners to Wasseralfingen, to study the processes as they are there carried on. The government of Wurtemburg have opened their works to the inspection of all who may wish to make themselves acquainted with their character.

The advantages arising from the employment of the waste gas from the mouth of the blast furnace, is no longer problematical, and as some of those interested in this matter may not be acquainted with the method by which the gas is collected and employed, a few words explanatory of it will not be out of place.

The gas, as it rises through the fire room of the furnace, containing from 60 to 80 per cent. of the combustible effect of the fuel used, is made to pass into a chamber surrounding the upper and outer part of the fire-room, some idea of which may be formed by the representation in fig. 1. B, is the mouth of the furnace; A, A, gas chamber surrounding the upper part of the fire room; D D, pipes connecting the fire room and gas chamber; C, C, pipes to carry off the gas, which is drawn out by means of blowing cylinders and forced into the refining, puddling, or other furnace, through a number of small orifices alternating with other orifices, through which a cold or hot blast of air is thrown that serves to keep up the combustion of the gas when once united; and by regulating the supply of air by means of stop-cocks, the maximum of heat can be obtained. In order to arrive at the maximum of heat, just sufficient air should be admitted to burn all the carbonic oxide and hydrogen contained in the gas coming from the blast furnace. If the amount of air be too small, some of the combustible gases pass out unconsumed; if too great, the excess cools

Fig. 1.



the furnace, and at the same time oxidizes the metals undergoing refining. The regulation of the supply of the blast is of the utmost importance, and is said to be easy of accomplishment.

The differences between the reverberating furnaces worked in this way and those in which coal is used, is that carbonic oxide with a little hydrogen is the fuel, and it is burnt by a full supply of air. It is hardly necessary to say more of the advantages that are to arise out of this important change in the working of iron; for there is no expense for fuel in the refining of the pig, as the gaseous combustible issuing from the mouth of the blast furnace is more than sufficient to refine all the pig made from the furnace. The quality of iron is also improved, as none of those impurities contained in the coal and other fuel can interfere in the working of the iron.*

The sooner these modifications are introduced into our furnaces, the sooner will we be able to place iron in the market at a price to compete with that coming from any other quarter of the world, and entering our ports free of duty; at the same time it will increase the value of those works whose wood-land has been diminished by a too rapid and improvident use of fuel.

I next pass on to make a few remarks about the *refining furnace* used in the working of iron. In these furnaces the air is thrown, by one or two tuyers, into a crucible filled with charcoal, into which the pig to be refined, along with scraps coming from previous operations, is placed in a certain relative position. The change that takes place by the reaction of the air upon the coal, is similar to what occurs in the lower part of the blast furnace, namely, the conversion of the oxygen into carbonic acid, which is immediately changed into carbonic oxide. The analyses of the gases taken from the centre of the furnace, prove that the trasformation of the oxygen into carbonic acid corresponds to the position where the workmen constantly place the iron that is about to be forged, and this is just what we should expect as it is the point of maximum temperature.

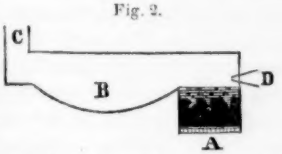
Ebelman states that the atmosphere which surrounds the melted iron, contains hardly a trace of carbonic acid, either in the blast or puddling furnace; this being contrary to the opinion which is generally admitted, that the decarbonization of the iron takes place by the action of the air during the melting of the pig, but it would appear that this reaction is attributable to the protoxide of iron covering the surface of the mass undergoing refining. In the second period of refining, in the puddling properly speaking, it is easy to deduce from the analyses of the gas, that there is oxidation of a considerable portion of the iron by the oxygen of the air thrown in at the tuyere.

Here again much of the fuel passes off under the form of carbonic oxide, thereby causing considerable waste. Of late years a modification has been introduced into the refining furnaces, even when the waste gases from the blast furnace are not employed; a modification by which none of the combustible is lost. A few words will suffice to explain how this is accomplished.

* If I mistake not, the Dufaur patent has been taken out in this country by Mr. Detmold, and has already been applied to one or two furnaces.—J. L. S.

All the furnaces are modifications of the reverberatory furnace. The fuel is placed upon the grate A, (fig. 2,) and ignited by air thrown in from below the grate, by a bellows or otherwise. The air in traversing the ignited coal is first converted into carbonic acid, and then, if the bed ofcoal be thick enough, this last will be changed into carbonic oxide. As this, however, is generally not the case, a part of the carbonic acid passes beyond the upper surface of the fuel without having undergone a change, particularly if the blast from below has been strong and abundant. By this operation the chamber B becomes heated, and a mixture of carbonic acid, carbonic oxide, nitrogen, and a little hydrogen passes out of the flue C. The object of the metallurgist, however, is not to permit any carbonic oxide or hydrogen to escape combustion, but to endeavor to add to the heat of the furnace that heat arising from the combustion of these two gases. This is readily accomplished by throwing in a second blast of air, through a number of small orifices just above the surface of the fuel, D; this blast to be regulated as required.

Fig. 2.



By this process, we re-create, as it were, the maximum intensity of heat, (which first shows itself at the lower part of the fuel on the grate, just where the air becomes converted into carbonic acid,) and in the chamber B, where it is most wanted; for the amount of heat rendered latent by the reduction of the carbonic acid into carbonic oxide, is rendered sensible by the reproduction of the former.

The advantages arising from this method of burning the fuel, are important. In the first place, the heat is diffused over a larger space, thereby heating more uniformly the metal, than when it is placed in the midst of the fuel. Again, fuel of the most inferior quality can be made use of, and as evidence of this in some trials made at Audincourt, it was proved that the reverberatory furnace could be heated to whiteness by burning the gas, and the pig melted and puddled, when a mixture of charcoal dust and earthy matter was made use of as fuel.

Ebelman, whom I have so often quoted in these articles, and who has certainly made the best series of scientific researches upon the subject, says that, instead of employing the action of air upon an excess of charcoal to produce the combustible gas, the vapor of water may, to an extent, be substituted, which produces, in contact with burning charcoal, carbonic oxide and hydrogen.

The heat of the combustion of equal *volumes* of hydrogen and carbonic oxide is about the same, and it can be easily deduced that the decomposition of the vapor of water by the charcoal, determines an absorption of latent heat, equal to that which is produced by the transformation of the same volume of carbonic acid into carbonic oxide. The vapor of water alone passed through the ignited coal produces all the effects just mentioned, but the absorption of latent caloric is so great as to cause the operation to cease in a few minutes. By projecting, however, a mixture of air and the vapor of water through the coal, the operation is said to be carried on advantageously.

It was my intention to have remarked at length about the effects of the hot blast, but it is now so generally admitted that the hot is to be preferred to the cold blast in reducing the iron from the ore, and bringing it to its most refined state, that any thing on the subject at this time would be superfluous. All that is important to make known upon this subject, is the results lately arrived at by M. Scheerer* as to how it is that hot air produces such remarkable effects in the blast furnace.

By calculations based upon his own experiments as well as those of others, he was led to the conclusion that the most elevated temperature that charcoal could produce in burning in air, is 2571° Cent., which is that at which platinum melts. This temperature is situated in the middle of the space upon which the air is projected, and it goes on diminishing towards the exterior, so as to form a space for melting, the centre of which is at 2571°, and the exterior at 1550° Cent. When the hot blast is made use of, the temperature of the centre does not change, but the portion heated to 2571° becomes more extended. The exterior of the mass, which was at 1550° while using the cold air, acquires, when the hot blast is employed, a temperature as many degrees higher as there is difference between the temperature of the two blasts; for instance, if the temperature of the air be 280° C., that of the exterior of the heated mass will be 1830° C.—if 300° C., the latter will be 1850° C.

Thus the influence that hot air exercises, is to extend the space of fusion, which is twice as great with the air at 300° C. as it is when the air is at 0° C.

Amer. Jour. of Sci. and Arts.

Statistics of the Coal Trade.—The Coal Measures of Britain.

The coal measures are not confined to the north of England, in Northumberland and Durham; they are to be found, fortunately for this country, forming large portions of the stratification in many districts of the three kingdoms. From the Grampians to Sussex, and from the German Ocean to the Irish Sea, the predominating geological feature of the British island is the "carboniferous series," with the most magnificent coal deposits accessible in every direction. These have been the source of Britain's internal riches, and the great cause of the development of the mechanic arts, which distinguish her above all other countries. Had the granite of the Grampians, it has been said, and said justly, extended into Sussex, or the chalk of Sussex to the Grampians, the whole course of British History would have been changed. Nineteen of our most important manufacturing cities, which lie upon the new red sandstone, drawing from beneath them the coal, iron, and lime—the sources of their manufacturing prosperity—in either case, it is probable, would never have existed.

In Ireland, the coal measures exist in the provinces of Munster, Leinster, and Ulster; in Clare, Limerick, Monaghan, and Kilkenny.

In Scotland, in the shires of Ayr, Renfrew, Linlithgow, Fife, Edinburgh, and Haddington.

* Pogg. Ann. lix. p. 508.

In England, in the counties of Cumberland, York, Derby, Nottingham, Lancaster, Stafford, Chester, Flint, Leicester, Warwick, and Gloucester.

And in South Wales, in Monmouth, Glamorgan, and Pembroke, as well as in the two northern counties of England.

By examining a geological map, it will be seen that the northern coal-field is exceeded in superficial area, by the Irish field in the province of Munster; by the Scotch, which crosses the breadth of the island from Ayr, on the west, to Haddington, on the east coast; by the English in the Yorkshire and Derby field, extending through a great part of two counties; also by the Lancashire; and infinitely surpassed by that of Glamorganshire and Monmouthshire, in South Wales. The extent of area of—

South Staffordshire may be reckoned at	100	square miles
The Northumberland and Durham,	360	"
The Lancashire may be taken at between	500 and 600	"
The Yorkshire and Derbyshire nearly	700	"
And the South Wales,	1000	"

The north of England coal-field contains about 30 seams of coal—making a total thickness of about 30 feet.

The South Staffordshire contains only about 11 seams, but, to compensate, there is one 30 feet thick; whilst in the north, the average thickness of the best coal is under 6 feet.

The North Staffordshire possesses more than 30 seams—from a few inches to 10 feet in thickness.

The South Wales possesses about 100 seams—making 95 feet of coal, the thickest of which is 9 feet; the coal measures being about 12,000 feet.

The Lancashire has 75 well-defined deposits of coal—making about 150 feet total thickness.

The coal-field of the Clyde Valley has 84 separate seams, with a seam of 9 feet, thick; the entire thickness of these coal measures being reckoned at 5000 feet.

In Ireland the chief field worked is that of the Leinster; but, near Tyrone, an exceedingly fine deposit of bituminous coal has been found, from 20 to 30 feet thick.

One geologist, Conybeare, in his *Introduction to Geology*, states that the Yorkshire and Derbyshire Coal-field rivals, or surpasses, in importance that of the north, and which he conceives to be the re-emergence of the latter from beneath the magnesian limestone. Another geologist, Bakewell, in his *Geology*, calculates the South Welsh basin to be about 1000 square miles of 95 feet of coal, containing 100,000 tons per acre, or 64,000,000 tons per square mile—or almost as much as will supply the country at its present rate of consumption, for 3000 years. A matter of comfort for the present generation.

This sort of calculation, by Bakewell, of itself amounts to nothing, without taking into account other elements—as accessibility, facility of carriage, capital, and labor, and comparative qualities. For many years the difficult accessibility of some of the best Durham coal prevented its working—for want of the facility of carriage, now to be

removed, all the Midland coal has hitherto been kept out of the market—for want of capital and cheap labor in America, English coal can be delivered upon the finest coal deposits in the world, 3000 miles away, in the United States, at less cost than the coal beneath can be worked; and, by comparative quality, the finest coal of the Tyne having been much exhausted, the less worked coal of Durham, in the same field, brings 2s. per ton more in the London Market. The possession of a coal deposit, is not enough of itself, as these facts demonstrate.

Their Qualities.—The proportionate quantity of gas yielded by the Scotch cannel, the Gloucester cannel, the Lancashire and the Cumberland coal, and the constituents of these and other coals, demonstrate many of them to be equal, and, in some points, some of them superior, to the northern coal.

Mr. Accum, in his experiments at the Royal Mint Gas Works, procured from an equal quantity (one chaldron) of the following different specified coals, these results:—

	Cubic Feet of Gas.
Scotch cannel coal,	19,800
Lancashire cannel coal,	19,608
Gloucester coal, best,	16,584
Newcastle coal, best	16,920
Ditto another variety,	16,584

The Warwickshire coal continues to give out good gas longer than either the Newcastle or South Wales.

Their Constituent Principles.—The following are the general constituent principles of different varieties of British coal, as shown by Kirwan, Dr. Watson, Dr. Ure, Karsten, and others:—

	Volatile Matter.	Charcoal.	Earthy Matter.
Newcastle,	40·	58·	1·80
Whitehaven,	41·6	57·	1·7
Lancashire,	36·7	61·73	1·57
Derbyshire cannel,	47·	48·36	4·6
Scotch cannel,	56·57	39·43	4·
Leitrim,	23·37	71·43	5·20
Alfreton furnace coal,	45·60	52·45	2·04
Swansea,	23·94	73.53	3·3
Welsh furnace coal,	8·59	88·06	3·4
Welsh stone coal,	8·	89·70	2·3
Kilkenny,	0·	97·3	3·7
Anthracite,	0·	97·25	2·7

In this list we perceive a richer and more bituminous coal than in the Newcastle, in the Whitehaven, Scotch, and Derbyshire cannel, and Welsh coals. The too frequent explosions of fire damp amongst them give indications of their rich gaseous and bituminous composition; and in the Irish, Kilkenny, Welsh stone coal, anthracite, and Swansea, we find, for smelting of iron and steam purposes, a coal infinitely better adapted for these most useful objects than that of the northern field. The coals of the northern field, though, to a certain extent, uniform in each mine or locality, differ widely as to their nature and quality throughout the whole deposit—hence the value of

the produce varies at this moment in the London market from 11s. 9d. (Oakwellgate) to 17s. 3d. (Haswell): the average of the three lowest being 12s. 7d., and three highest 16s. 11d. per ton—a difference of upwards of 30 per cent. Whatever be the result to the superior description, the inferior quality, forming more than one-half of the coals shipped to London and the other coast markets, will the more easily meet with successful competition from the southern and western fields.

With regard to the anthracite description of coal, Lyell states, in his *Geology of North America*, "that, as managed by the Americans, I have no hesitation in preferring its use, in spite of the occasional steam-like heat produced by it, to that of bituminous coal in London, coupled with the penalty of being constantly in a dark atmosphere of smoke, which destroys our furniture, dress, and gardens—blackens our public buildings, and renders cleanliness impossible." The anthracite which he thus eulogises is similar to much of that of South Wales—it burns without smoke, leaving a clear atmosphere. Some of the American manufacturing cities having over them an atmosphere as pure as that of Naples. Notwithstanding all these advantages (and they are many), and the eminent opinion just quoted, we question much if this anthracite, with its difficulty of lighting, its sluggishness, and drying effects on the air of rooms, even with the assistance of the Arnott stove, will displace the best bituminous sea coal of the north, with its cheerfulness, light, and warmth. The smiling comfort of an English fireside consists materially of these qualities, and we hold with Professor Ansted, in his *Text Book*, that "the coal of the northern coal field is the most bituminous, and the best adapted for economical purposes of any yet known."

From the fortunate union and proportion of volatile matter and charcoal in the best description of northern coal, with its great freedom from earthy matter—its abundance and accessibility—it has, up to this period, enjoyed, not only at home, but in the markets of the world, a pre-eminence and demand beyond rivalry. These are the causes of its success, in our opinion, though, we must admit, it is not that which generally obtains throughout. We must not blink the fact, that practical men entertain the opinion that the more accessible position of the northern coal-field, intersected by three navigable rivers, has been the chief cause of this advantage; and that it will be reduced, if not altogether destroyed, by the at least equal facilities of carriage, soon to be afforded by the established and projected railways to the other valuable coal districts of the kingdom. It would not be safe, in an inquiry of this nature, to throw discredit upon that belief, or to abstain from weighing its consequences, because they may be of a serious and injurious nature—such a procedure would not prevent, but might facilitate, the dreaded results. A wise course in this, as in all difficulties or dangers, seems to be to look the evil firmly in the face, and calmly to investigate its nature and mode of approach; then, with a full knowledge of all the circumstances attending it, to decide clearly, and act with energy. It is safer thus to do than to affect to despise what you fear—to shut the eyes to it, and fancy it afar off, till it is upon you, and unpreparedly overwhelms you. That would be

to see the cloud that bears the hurricane, and to send all hands below, and not to furl the sails and prepare for its furious bursting.

We have seen then, that, in extent and abundance, the northern coal-field is infinitely surpassed by the deposits of the other districts, and that it is approached by many of them in quality, and in some instances exceeded, for particular purposes. These immense resources of British mineral wealth, it appears, only require favorable opportunities and means of transport for their development.

Their Geological Accessibility.—That it is not the geological accessibility of the northern coal that gives it its advantage, may be inferred, when it is stated, that the mines for this coal are the deepest and most expensive in the country, frequently overlaid with immense feeders of water and quicksands, as that of Haswell, discharging 1000 gals. a minute; or that of Datton-le-Dale, requiring pumping-engines to the amount of 1274 horses, to enable them to pass a quicksand. Some of these mines are 1200, 1300, and even 1700 feet deep,—as the Monkwearmouth, 1794 feet, costing upwards of 80,000*l*, whilst those of Derbyshire and Leicestershire seldom are more than 700 or 800, but occasionally 1200 and 1300—(near Chesterfield the pits are from 300 to 500 feet deep, from which coals are now being sent along the railways to London)—those of Staffordshire are generally only from 100 to 600 feet deep—the average being about 450 feet, the deposit frequently rising to the day; Lancashire, on an average, are from 750 to 100; and Wales generally much less, even than the Staffordshire, and are often worked level free—so that, on this point, the northern coal is placed at great disadvantage. It has thus been a combination of quality, geographical accessibility, and unusual facilities of transport, that has hitherto given a predominance to its demand.

Now, let us exactly see our present position. Nearly similar good qualities with the northern have been discovered in other British coals, more abundant, and, geographically, more accessible, but kept out of the market hitherto, except the local supplies, by their geographical and topographical position in the interior, removed from convenient shipping ports. This obstruction to their general competition, which has aided to produce the almost monopoly of the northern coal trade, and the consequent splendid commercial marine attached to it, is, however, it is calculated, about to be greatly reduced, if not entirely removed, by the facilities of conveyance of the numerous lines of railways, entering and intersecting all the British coal-fields, which will transport their produce to London—the great mart of the northern coal, and distribute it to all the various towns and districts of the country.

Distances of the several Coal-Fields from London.—The statement of the distances of the different coal-fields from London, in whose market—the seat of its strength—the northern coal will encounter its great competition, is all that remains, with the cost of transit on railways, to demonstrate our position:

The Warwickshire Coal-field is under	100 miles	from London
The Staffordshire Coal-field is less than	125 "	"

The Leicester Coal-field, at Leicester, is	122	miles	from London.
The Great Coal-field of Derbyshire and Yorkshire, at Derby	152	"	"
The South Wales Coal-field, at Merthyr Tydvil, is	135	"	"
The Lancashire Coal-field is about	190	"	"
The Great Northern Coal-field, at Newcastle, is	270	"	"

So that, in a competition of carriage of coal by land to London, the northern coal-field will be cut off by the nearer, and then the more fortunately-placed coal fields, which will enjoy the advantage by land that the northern does now by sea. A reflection deeply interesting to the northern coalowner as shipowner.

It is an interesting fact, that the various coal-fields of England and Scotland will, from each adjoining field, meet the next adjacent nearly on a radius of 30 miles, forming a chain of deposits from Scotland to South Wales. That, therefore, the whole country, from north to south, will be supplied with coals, nearly within their circumference, from their several points. The east and west coasts,to their very verge, not exceeding 50 miles at any point, from the nearest coal district. The south-east and south-west of England, and the north of Scotland, and north-west of Ireland, possessing the most distant points, yet those not extending over 150 miles, will show the easy practicability, by railway facilities, as existing on several of the combined goods and passenger lines, of supplying land-carried coals, exclusive of sea-borne, to the entire country.

If London then, not more than 100 miles from the nearest mines, can be supplied with railway-carried coals, it is evident that the country, at no point 50 miles from the mines, with immaterial exceptions, will be more certainly supplied by similar means. Min. Jour.

On the Manufacture of Glass. By Mr. Pellatt.

Though we have accounts of foreign glass having been used in this country during the seventh century, yet the manufacture of glass in England is comparatively of recent date; the first manufactory having been established at Savoy House, in the Strand, in 1557, probably by French Protestant refugees, most of the technical terms in glass making being from the French. In 1670, the second Duke of Buckingham advanced the manufacture by the introduction of Venetian workmen; and three years afterwards the first plate of glass was produced at the works of that nobleman at Lambeth. In 1773, a royal charter was granted to the Governor and Company of British Plate Glass Makers; their works are at Ravenshead, Lancashire, and are the most capacious in Europe. Since this period, the manufacture of glass, notwithstanding the restrictions to which it has been subjected, but which are now removed, has continued to advance. Before considering the manufacture of glass, it is necessary to say a few words respecting the mode of preparing the crucibles and furnaces for melting the materials. Every glass maker is his own potter and furnace builder. The preparation of the crucibles involves the greatest care,

because upon the quality of them depends all the after processes and results. The material used is fire-clay. The clay best suited is that which contains the most silica. The crucibles or pots are made by forming the clay into small rolls, which are spread, layer over layer; with considerable pressure: the whole is thus built up little by little, allowing the clay to harden, so that the shape is preserved. During the building and afterwards, the pots are in a room in which the temperature is regulated at about 60°, and all draughts excluded; five or six months are required in this temperature to dry them. The reason of so much care is to exclude as much air from the clay as possible; which, if it existed in quantity, would, upon the pot being brought into contact with the high temperature of the glass furnace, become so expanded as to burst; and also to insure a capacity in the pot to withstand the sudden contraction and expansion to which it is exposed. Pots are of two different constructions—closed and open; the former are used only for *flint* glass, the latter for all other descriptions in both shapes. The upper part is the most capacious: the reason for this is, that the heat reverberates from the top of the crown of the furnace directly upon the top of the pots. The pots cannot, of course, be exposed *cold* to the heat of the furnace, but have to undergo a gradual heating till they attain a white heat, and this is done in a furnace constructed for the purpose, from which all air is carefully excluded; from this furnace they are removed upon iron carriages to the glass furnace. The heat required to melt glass, especially that made without lead, is very great; yet, on account of the danger to the crucibles from any sudden rush of air, it is impossible to make use of blast, or even fanners: the proper draught is secured by the construction of an air funnel, called a cave, and by having the glass-house so constructed that it can be closed from the entrance of external air above. Upon the arch of the cave the furnace floor or seige (from the French *siège*, seat of the pots) is constructed, formed of strong heavy square bricks. The round furnace is used for flint glass, the flames finding vent by flues passing through the pillars of the furnace, having chimneys upon the outside for carrying off the smoke. Square furnaces, again, are employed for glasses without lead, a greater heat being required; which is obtained by the grate-room running the whole length of the seige. The proper construction of the furnace is of great importance to the operations of the glassmaker; in fact, good glass cannot be made without a good furnace. There are several distinct varieties of glass manufactured; and so different are they, both in preparation and manipulation, that they may be considered separate manufactures. There are, however, only two methods by which fluid or semi-fluid glass is formed to shape, viz. casting and blowing. Casting applies *exclusively* to *plate* glass, and is the emptying the glass out of the pot by casting it out upon a table, the casting of glass as metal is cast being yet unpractised: *blowing* applies to *all* other descriptions of glass.

The tools used by the glassmaker are simple: the blowing iron —simply a hollow tube; with this the semi-liquid glass is gathered from the pot and blown out into shape; the punty, for attaching to

the bottom of glass after blowing, so that the blowing iron may be detached, and the glass, being heated up, may be cut with scissors, and afterwards formed. The shears or procellos, for shaping the glass whilst it is turned by the workman upon the arms of his chair, or working bench. These, with the addition of a pair of scissors and pincers, are the whole of the tools.

All glass requires annealing, or cooling; the process is performed in a furnace called a lier, from the French *lier*,—figurative, perhaps, of the change in state, as well as atomic arrangement, which takes place during the cooling. We know that a change *does* take place, from the fact that glass before cooling is of greater bulk and less specific gravity then when cold; that it parts with a portion of *color* during the process, probably by giving off oxygen; and that though, whilst in a fluid state, glass is a good conductor of electricity, when cold it is a non-conductor. The object of annealing is, by a gradual diminution of the temperature, to allow of that arrangement of particles necessary to the body at a low temperature, and which particular arrangement alone enables the glass to support sudden changes. The base of all glass is silica: the most convenient form in which it is found is in fine sand; upon the due proportion of this substance in glass depends its compactness of body, brilliance, and capacity to withstand sudden changes. It often happens, either on account of want of sufficient heat in the furnace, or in order to save time in the melting or founding, that too small a proportion of silica is employed. Glass which has this fault may be known by its rapidly attracting moisture. The different kinds of glass made are known by the names of plate glass, German sheet or British plate, crown or window glass, bottle glass, and flint glass; there are others, but they are merely modifications of these, and need not be noticed. Plate glass is composed of sand, carbonate of soda and chalk, with small quantities of arsenic and manganese; the proportions vary at different works, but the general proportion is—Lynn sand, 400; carbonate of soda, 250; ground chalk, 35, by weight. The quality of the glass depends upon the quality of the alkali. Plate glass is melted in large open pots. The furnaces are square, containing sometimes 4, sometimes 6 pots each; when the glass is melted, which takes 22 hours, it is removed to another furnace, where the pots are smaller, of a cylindrical form. Here it is fined, which occupies from 4 to 6 hours, and when free from air bubbles and impurity the pot with the glass is removed bodily from the furnace by means of a crane, and hoisted to the end of the casting-table, upon which the glass is emptied; a large iron roller which works inside the flanches of the casting table is then made to pass over the melted glass, in order to flatten it out; it is then removed upon a wooden table on wheels to the annealing arch, which is now at a high temperature, and here it is excluded from the atmosphere until cold. The glass is rough and uneven, but it is afterwards cut flat by machinery, and then smoothed and polished; it is these processes which render plate glass so costly. Crown, or window glass is of much the same composition as plate glass, except that a cheaper description of alkali is used; the ordinary mixture is, 500 cwt. Lynn sand, 2 of ground chalk, and 1 cwt.

each of sulphate and carbonate of soda. The square furnace and the open pots are used, there being generally six pots on each furnace. It takes from 14 to 20 hours to melt this glass, and it then requires to stand 4 to 8 hours to allow it to become free from all air bubbles, and to cool sufficiently for working. Window glass is formed by blowing: upon the blowing iron is gathered, at three several times, (the fluidity of the glass never allowing fewer,) the weight of glass necessary to produce the table, and which weighs 11 lbs.; this is then blown out, leaving a solid lump at the furthest extremity from the blowing iron, for attaching the punty; this is called the bullion. The punty being fixed to the bullion, the blowing iron is relieved by merely touching the glass with a wet iron; being firmly attached to the punty, it is removed to a small cylindrical furnace, called a flashing furnace, where a rotary motion being given to it, increasing as the glass becomes softened by the heat, the centrifugal force, together with a little sleight of hand on the part of the workman, produces a flat circular plate or table, as it is then called.

British plate, or German sheet, glass is of the same composition as plate glass, but the manipulation is different. The glass is blown into open cylinders, and, when cold, th·se are cut open along the length with a diamond, and placed in a flatting furnace, which is at a sufficient heat to bring the glass into a semi-fluid state, so that it falls quite flat. The sheets thus made are afterwards cut flat and polished. The size of the sheet is restricted to what can be blown and worked by one man; it is cheaper than plate glass, because all waste is avoided, and less cutting is required. Bottle glass is composed of the cheapest materials which can be procured—ordinary pit sand, refuse alkaline waste from soap works, refuse lime from gas works, &c. The proportions of the materials vary according to quality. Bottles are blown in moulds: the glass having been blown in the mould, nothing remains but to form the mouth; this is done, the bottom being attached to an iron punty, by holding the extreme edge of the neck to the heat for a short period, and, having collected a small quantity of liquid glass upon the end of a small iron, called a ring iron, a ring of glass is allowed to cover this extreme end, and this is afterwards worked into shape by a machine which forms the inside and outside of the mouth at the same time, merely by the workman turning the bottle on the iron upon his knee once or twice. The rapidity with which bottles are made is almost incredible; a workman, with the assistance of a gatherer and blower, will begin and finish 120 dozen of quart bottles in 10 hours, which averages nearly 2¼ per minute, and this is ordinarily done; and in some works the men are restricted to 2 per minute, to prevent the work being slighted. It may not be uninteresting to observe the low price at which this description of glass can be produced, now that the duty has been removed: quart bottles can be produced at the works at about 14s. per gross; each gross weighs 2 cwt., which is equal to 7s. per cwt., or 7*l.* per ton for manufactured bottles; if from this we deduct, for workmen and incidental expenses, 2*l.* per ton, it would leave the price of bottle glass 5*l.* per ton.

Flint glass is thus designated from calcined flints having been for-

merly used in its composition; this is now replaced by fine sand. The term flint glass is now applied to all glass into the mixture of which lead enters, and is used in the manufacture of table glass, &c. In the manufacture of flint glass the circular furnace is used, the pots surrounding the grate-room; on either side of the pots are flue-holes, which pass through the pillars, the smoke being carried up by flues outside these. The heat thus reverberates from the crown of the furnace, and is drawn round the pots previous to passing through the flue-holes. The melting pots are covered in, to protect the glass from dust, which would affect the color. The materials used in flint glass are sand, red lead and litharge, carbonate and nitrate of potash, arsenic and manganese; and the greatest care is taken in the selection of them, the beauty of the glass, depending mainly upon the quality of the materials. The best sand comes from Alum Bay, Isle of Wight; this is carefully washed and dried previous to using. Red lead, or litharge: this assists as a flux, and gives density, brilliancy and ductility,—the latter quality being particularly required in flint glass; it is, perhaps, owing to the superior quality of the oxides of lead prepared in England that we are in advance of other nations in the manufacture of fine flint glass. The carbonate and nitrate of potash are used wholly as fluxes; soda, though more active, is never used where quality is required, as it affects the color. For almost every purpose, the best glass of every description is that which contains the greatest amount of silica. If the sand, lead and alkali, even though the quality were never so pure, were melted, the glass which would be produced would not be colorless, but of a pale green; and this, in all probability, is not so much the result of impurity, as the deoxidizing effect of the fusion. To obviate this, it is necessary to use the oxide of manganese, which, by supplying oxygen, retains the different substances in that state of oxygenation necessary to a colorless glass; if too much manganese be used the color is slightly purple, designated by the glass makers "high;" the green tint, again, is called "low:" in other words, the glass is high when it contains more than sufficient oxygen, and low when too little. Minute quantities only are necessary; from a quarter to half an ounce per cwt. is sufficient. Arsenious acid is sometimes used in flint glass, its use being to expel the carbonic acid gas present in the materials; if too much is used it gives opacity.

Glass must be considered, unfortunately for science, an imperfect body. The principal imperfection, more especially of flint glass, arises from what are called cords or striæ in the body of the glass, which give it the appearance of alcohol and water imperfectly mixed; through these striæ the rays of light will not pass, but are diverged and broken. This defect is attributed to the difference in specific gravity, or want of homogeneity of the particles; this, no doubt, is true; but the question is, to what cause is this attributable? I would suggest, that it may arise from the unequal distribution of heat to the materials during fusion and whilst in a fluxed state, and to the particular action consequent thereupon. The number and variety of articles manufactured in flint glass are great, and require considerable practical experience on the part of the workmen. It is impossible to describe the manner of operating, which appears even to

those who have often seen it almost magical. It is certainly surprising to see an apparently opaque and fluid body in a moment become transparent and solid, and, whilst undergoing this rapid change, to see it take beauty of form. The substances used for producing colored glass, are the metallic oxides, the quantity being proportioned to the depth of color we desire to obtain. For blue glass we use oxide of cobalt; this produces a rich color: the material, however, being expensive, it is seldom used by the glassmaker alone, but generally with an equal quantity of manganese: this materially affects the richness of the color. Green is obtained from the oxides of copper and iron, mixed, the protoxide of copper and the peroxide of iron: equal quantities may be used, the proportions being varied according to the tint desired to be obtained: the copper produces a blue-tinted green, and the iron the yellow tint. Purple is obtained from the oxide of manganese; the purer this substance is, the finer will be the color. The pyrolucite already referred to, especially when used in small quantities, gives a beautiful and delicate amethyst color. Ordinary yellow is got from carburate of iron and oxide of manganese. Ruby is obtained from the oxide of gold, called the cassius precipitate; it is a color which is neither obtained nor retained with any certainty—in fact, the modern glassmaker is quite at a loss for this color. There can be no doubt the ancients manufactured ruby of a much finer color than any now made, from sub-oxide of copper; this art has been lost for centuries: the difficulty is, the preventing this substance from peroxidizing. The oxides of uranium produce beautiful tints in yellow and green. Copper scales give azure blue; oxide of chromium, emerald green. Opaque glass is produced by the addition of phosphate of lime, arsenic, and other substances. The addition of many of the metallic oxides renders glass less ductile; and in making use of these it is always well to employ an additional quantity of lead. We often hear of the superiority of the color of ancient sheet glass to the modern, and are bound to conclude, when we see, particularly in church windows, the difference, that there is good ground for the assertion. With the exception of ruby, the modern colors are all finer than the antique. I speak of body colors—that is, glass made of colored mixtures, called pot metal; but this is seldom used, all our modern church windows being made of white glass stained with metallic colors; this saves trouble and expense in the fitting. Glass of various colors in the same piece is obtained by casing one metal or glass with another. A small quantity of one color having been gathered, it is blown into a small ball, and dipped into a pot of a different color; this being rolled on an iron slab, so that an equal thickness of the second covers the first, the ball is a trifle enlarged by blowing, and may be dipped into a third and fourth color. Care must be taken that the character of these different glasses exactly agree, that the contraction in cooling may be alike.—*Trans. Roy. In.* Athenæum.

Painting on Glass.

There are three kinds of painting on glass; painting with the different colors on separate pieces of glass, painting on uncolored glass, and

painting on crystal. The first two methods are frequently combined so as to constitute a fourth kind of painting on glass. The first kind of painting is incontestably the most ancient. Glass is prepared in sheets, blue, violet, yellow, green, and red, and after being divided into pieces of the proper size and shape, the separate portions are put together by glaziers' lead.

The preparation of purple glass has fallen into such disuse, that till very recently, the art was considered to be entirely lost, but this is not the case, for there still exist printed receipts which describe all the details of the operation. Baptiste Porta, who was born in the year 1540, has given one of the receipts in his *Magie Naturelle*, and he has taken care at the same time to warn us of the difficulty of obtaining a successful result. Other receipts are found in the compilations of Néri, Merret, and Kunckel, and have been transferred to the encyclopædia. No information, however, is given respecting red glass. It is not prepared with the purple of gold, for this substance gives neither a scarlet red nor the red of clear wine: instead of oxide of iron, the protoxide of copper is used. But as this last produces an exceedingly deep color which deprives the glass of its transparency, the usual plan is to cover white glass with a thin layer of red glass, so as to form a kind of plated glass. The process is as follows:—there are placed in the furnace two crucibles, of which one contains common glass, the other glass of the same composition, but colored with protoxide of copper, to which is added protoxide of tin. This last body tends to prevent the oxidation of the protoxide of copper which would have the effect of coloring the glass green. A small addition of protoxide of iron gives a scarlet red or flame color. If the glass take a greenish tint, a little bi-tartrate of potash will renew the colors by restoring the bi-oxide of copper to the state of a protoxide. The workman commences by taking on his "blowing-iron" a small quantity of red glass; he then plunges the tube into the white glass, of which he takes a much larger quantity, and he then blows it out according to the ordinary method of making "tables" of crown glass. This method was employed for the ancient glass of church windows; at the present day this glass is manufactured at Hoffmungsthal, in Silesia, by the Tyne Company in England, by Bontemps in France, and at Besançon.

The glass, as has been said, is cut up into colored plates. The tints and half tints are applied by means of colored enamels on one face or the other of the glass, which is exposed to heat, and the different pieces are joined by glaziers' lead according to the pattern or design. If the paintings be small, and designed to be viewed close, plated glass, and not glass colored throughout its thickness, is employed. Parts of the colored layer are removed at the requisite places, and on the white glass thus laid bare, the colors required for the painting are applied. In this way designs are obtained of which the colors differ altogether from the ground color. Instead of removing the colored layer by mechanical means, it may be destroyed by fluoric acid.

The effect of the weather insensibly alters the colors of ancient paintings on glass.

Painting on glass properly so called, that is to say, the application of colored enamels to uncolored sheets of glass was little known to the ancient artists, and it is only in our own day that the progress of chemistry has advanced this art to any degree of perfection.

Painting on uncolored glass was executed in 1800 by Dihl; it consists in tracing the same design on two sheets of plain glass, which are submitted to the action of fire, and then the faces on which the designs are drawn are laid one upon the other.

To fix by heat the colors on glass without altering its form, or fusing it, it is necessary to add vitreous matters, which are readily fusible, fluxes, which vary according to the nature of the colors.

Silicate of lead is employed with or without borax, minium and very fine sand are fused together, and different proportions of calcined silex and quartz. For instance, take

Quartz	3 parts or	Borax calcined	5 parts.
Minium	9 "	Quartz	3 "
Borax calcined	1½ "	Minium	1 "

The quantity of flux required for each color, so that it may have the required fusibility and clearness is very variable, the necessary proportion is in general three or four parts. All colors are not adapted for the same flux; the purple of gold, the blue of cobalt, require an alkaline flux; the minium injures these substances, while other deep colors are not injured by fluxes into which lead enters.

Some substances require to be vitrified with the flux proper to them, before they can be employed in painting, as the feeble heat to which they are subsequently subject is not sufficient to develop the color properly. The deutoxide of copper, and the yellows, blues and violets, are among these substances. With purple of gold and oxide of iron, on the contrary, great precautions are necessary to prevent the injury of the color by too great heat. The colored enamels when prepared are reduced to powder; and preserved from the action of moisture.

All kinds of glass are not suitable for painting. Excess of Alkali is destructive; preference is therefore given to the hardest glass, which contains a great deal of silex, and which does not attract moisture, as the Bohemian glass for instance.

Before applying the colors with the brush, they are mixed on a palette with turpentine. When the painting is finished the colors are fixed by heat, an operation which requires great care and experience. Pots of fire-clay closed by a cover of the same substance are placed in a support of iron, so that they can be enveloped on all sides by the flames; the method adopted in France for cooling glass is to put it in separate furnaces heated by charcoal. The plates of glass are laid one upon another on clay slabs, supported on props of the same material. The heat is judged of by trial-pieces, which are introduced with the rest of the glass into the furnace, and are withdrawn with a spatula. When the colors are well vitrified, the plates are put in the annealing oven and gradually cooled. It is necessary that this last operation should be conducted very gradually, to insure the permanence of the colors.

The color communicated to glass by the protoxide of copper is, as has been observed, too intense to be employed alone, for it causes the "metal" to appear opaque of a deep brown. It is necessary, for procuring a transparent red, that the glass should be extremely thin. Consequently, the only means of getting red glass of a proper thickness is by covering plain glass by a thin layer of red. The plated glass has the advantage of allowing the partial removal of the red layer, in order to obtain white figures, or add other colors. The glass of the Middle Ages shows that this method was adopted by the ancients.

In order, that, when the red and white glass are blown together, they may be well united, and do not separate during cooling, (as happened in some of Engelhardt's first experiments,) the "metal" of both must be the same, or at least analogous. It is best to make the red a little weaker than the white; the latter must not contain any oxydizing substance, which would injure the red color.

Great care is required to avoid air bubbles in the glass. The red and white must be ready at the same time, in order to work together well. The beauty of the glass depends also materially on the skill of the workman, for it is easy to understand that the colored glass is always thicker near the orifice of the blowing-iron than at a distance. It is on this account that the glass is seldom of a uniform color, except in the middle of the plate: at the extremity of it the red layer is sometimes so thin that all trace of color is lost. Dr. Engelhardt has preserved several ancient specimens, in which this gradation from a deep color to a light one, has been made use of in a very happy manner to produce striking effects. After a certain degree of practice, the workman is able to obtain a tolerably uniform color, and Dr. Engelhardt expects to effect this object completely in a glass manufactory where he has directed attention to this particular branch of the art.

It is sometimes necessary, when the glass has once been painted and the colors fixed by baking, to add a second coat of painting; and as it is then necessary that the glass should be again subjected to heat, the coloring matter must be rendered so fusible by an additional proportion of flux as to avoid all risk of fusing the colors first painted.—*Translated from the Revue Scientifique et Industrielle.*

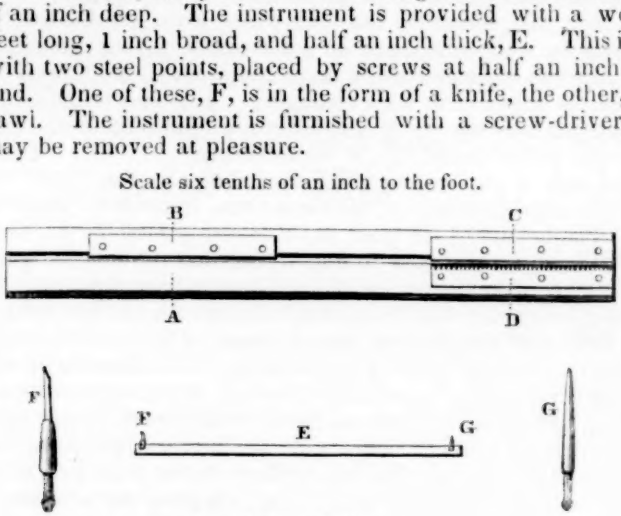
Civ. Eng. & Arc. Jour.

On a convenient Instrument for Graduating Glass Tubes. By Dr. Playfair.

Dr. Playfair described an instrument for graduating tubes, invented by Professor Bunsen, of Marburg, and used in the researches on the gases from iron furnaces, and in the late experiments read to the Society on specific gravity. It consists of a mahogany board 5½ feet long, 7 inches wide, three-quarters of an inch thick. Throughout its centre is a groove 1 inch wide, half an inch deep, arched at bottom, for the reception of tubes. At one part, five inches from the end, is placed a brass plate, 1⅓ foot long and 2 inches wide, in such a position, that when screwed down, its edge comes one-half over the groove,

It is furnished with 4 screw-nuts, passing through a cut portion of the plate, a quarter of an inch long, so as to allow a certain advancement or withdrawal of the plate at pleasure. C and D are two similar plates, (one foot 9 inches long,) placed at the other end of the wooden board, C having the same amount of motion as B, and being precisely similar in every respect. D is a brass plate of the same dimensions as B and C, but the screws go through a hole of the same size as themselves into the wood. It is cut, at intervals of five millimetres, into notches, every alternate one being one-twentieth and one-tenth of an inch deep. The instrument is provided with a wooden rod, 3 feet long, 1 inch broad, and half an inch thick, E. This is provided with two steel points, placed by screws at half an inch from either end. One of these, F, is in the form of a knife, the other, G, of a brad-awl. The instrument is furnished with a screw-driver, that these may be removed at pleasure.

Scale six tenths of an inch to the foot.



F and G are half size.

When a tube is to be graduated, it is covered with a thin layer of melted wax and turpentine, by means of a camel's-hair pencil, and is placed in the groove between C and D, which are then screwed down in their places, so as to retain the tube firmly in its position. A standard tube, previously mathematically divided into millimetres, (the most convenient division,) is now placed in the groove under B, which is then screwed upon it. The rod E is now used, the pointed steel G being put in one of the millimetre marks on the standard tube; the knife-formed steel, F, is now upon the waxed tube, and is made to make a mark upon it, the length of which is regulated by the distance between the edges of C and D. The pointed steel is now removed back one millimetre on the standard tube, and the corresponding mark made on the waxed one; and thus we proceed until the whole of the waxed tube is divided into millimetres. The object of the notches is, that a longer mark may be made at every five millimetres, and a still longer one at every ten, in order to aid the eye in reading. The waxed tube is now removed to a leaden chest, containing pounded fluor spar and sulphuric acid, slightly heated, which etches it more successfully than a solution of hydrofluoric acid. Previously, however, to being etched, it is desirable to figure the number of millime-

tres at the space of every ten; and this is conveniently done by the steel pointer G, after being removed from E.

We have thus an accurate measure of length etched upon the tube, which should have been one of pretty uniform calibre. The next point is to determine the true value of each of the divisional marks. This is done by calibrating it throughout all its length with small portions of mercury, say equal in bulk to five grains of water. By this means, the relative value of each mark may be determined, and the proportion which it bears to any given standard. The only possible error is in the assumption that the tube is of even calibre between the space occupied by the mercury; but the quantity of this added is so small that any such error becomes quite inappreciable.

The convenience of this graduator is so great, that a long tube may be beautifully divided in the course of a quarter or half an hour. The standard tubes should be made of glass, but the original divisions from which this standard is made may be made on wood or any other material.

Proceed. Chem. Soc.

On some Products of Chinese Manufacture collected by M. Jules Itier, Chief Inspector of Customs.

1. *On two kinds of textile plants, from which fine Canton lawn, or cambric, called in England grass-cloth, and coarse fabrics are produced.*—Several varieties of fabrics are to be met with in the Chinese market, differing very much from any European manufacture, particularly in respect of their stiffness and consequent coolness, on account of which they are much preferred by the Chinese to European manufactures. Amongst the number of these fabrics, which are manufactured at Quang Tong, where they are known by the generic appellation of *ha-pou*, (in Mandarin *cha-pou*,) are those known in France by the name of *Canton cambric*, and in England *grass-cloth*, and called by the inhabitants of Canton *yun-chest-yaô-ha-pou*, when in a raw or unbleached state, and *piou-pa-yaô-ha-pou*, when bleached; which, being literally translated, means *fine unbleached summer fabric*, or *fine light bleached summer fabric*. Besides this kind of cambric, of which there are infinite varieties as regards fineness of texture and consequent value, other fabrics of a coarser texture are manufactured, called *tso-ha-pou*, which means, literally, *coarse summer fabrics*.

The substance from which these various fabrics are made, is obtained from the bark of two kinds of textile plants, cultivated on a large scale, at a distance of 30 or 40 leagues N. E. from Canton, in the district of Si-Nam, and particularly at the small town of Hoang-Tchiang; they are known in the country by the name of *lo-ma*, (cannabis indica?) and *tsing-ma*, (corchorus?)

From the first, *lo-ma*, which is also cultivated in the environs of Canton and Macao, coarse fabrics are produced; from the second, *tsing-ma*, fine fabrics, or cambrics, are manufactured. Some fabrics are made by employing the *lo-ma* for the weft, and the *tsing-ma* for the warp.

The following is the method of cultivating the *lo-ma* :— After having manured the ground, it is well broken up, and in the rainy season, at the commencement of spring, the grain is sown very sparingly, and near the surface. The ground is then covered with a thick layer of straw, or dried herbs; and if it is a dry season, the ground is watered in such a manner that the water, dripping through the straw, &c., may act gently upon the earth, without any danger of washing away the seed. When the plant appears above ground, the straw, &c., is removed; and after being suffered to grow a little longer, the plants are thinned, so as to leave them standing at a distance of five inches apart. In about eight months, the plants will have attained maturity, and as they are of the class *diœcia*, they are treated in the same manner as hemp, *i. e.*, the male plants are first removed, after fecundation, and a fortnight or three weeks afterwards the female plants are gathered. The plant grows to a height of five or six yards, and is about two-thirds of an inch in diameter at its base.

In order to extract the thread, the plant is cut round outside near the root, and the outside, thus cut, is easily stripped off. It is then soaked in water for two days, and afterwards dried in the sun, and separated by hand into long threads, which are prepared for use in a manner similar to hemp.

Tsing-ma is cultivated in the same manner as the *lo-ma*, but it does not require so high a temperature. In order to prepare the thread, the plant is to be tied up, while green, into bundles of from three to four feet in height, and about eighteen inches in thickness, and placed upright over a large shallow iron vessel filled with water, the edges of which are raised by means of a lattice-work of bamboo, covered with clay. The furnace is then lighted and the water heated to the boiling point for several hours, until the plant is completely cooked by the steam; it is afterwards well dried in the sun, and soaked in cold water, and by dividing it near the root, the bark or covering may be easily stripped off. It is then split and divided into very fine threads, by means of combs, &c. The thread is made without any twisting, by simply joining the ends of threads of equal dimensions.

It is probable that these two qualities of hemp might be cultivated very well in Algiers, more especially in the plain of Mitidja, and also in the south of France. The naturalization of this plant would be the more desirable, as a well-known English manufacturer, Mr. Hargrave, announced in the *London Mail* of 24th June, 1845, that he had made a great many experiments on spinning *tsing-ma* thread by machinery, and the result was very satisfactory, as the thread produced was much finer and stronger than that obtained from any European plants, and that he was then manufacturing from it, fabrics as fine as French cambric.

In the spring of this year, M. Itier caused these two plants to be sown at Montpelier, Perpignan, Grenoble, Lyons, and Paris; and it is to be regretted that the Government has not caused any to be sown in Algiers.

II. *On the manufacture of thread, or yarn, and fabrics, from abaca, nipis, and pina, indigenous to Manilla.*—Abaca or Manilla

hemp is the produce of a banana tree, indigenous to the Phillippine islands, and known to botanists by the name of *musa troglodytarum*. It is cultivated, on a large scale, in the provinces of Camarines Norte, Camarines Sur, Albay, (Island of Luçon,) Samar, and Leyte,—islands bearing those names.

For this purpose the sides of mountains, newly cultivated, are preferred. The young plants, after having their tops cut off, are placed at a distance of fourteen feet apart, in holes about six inches square. During the first two years this plantation only requires weeding twice a year, in order to destroy the noxious weeds, which would soon kill the plants; in the course of the third year the largest stalks are cut. As the banana tree possesses the property of continually putting forth fresh shoots, the plantations will last for any length of time.

In order to prepare the *abaca*, the banana top is split into several long strips, which are passed between a thick plank placed in a horizontal position, and a metal blade pressed forcibly upon it; the strip is drawn through, and in this manner scraped, and the fibres deprived of the pulpy integuments; they are afterwards dried in the sun, and are easily separated; it then only remains to sort them and tie them together.

It is calculated that a foot of banana will furnish from ten to twelve ounces of thread, and that one workman can prepare 50 lbs. of abaca *per diem*.

Before the year 1823, the production of abaca was of very little importance; not more than 200 lbs. per annum were exported. The quantity exported now is upwards of 2000 tons. Ropes, cordage, and various fabrics, are made with abaca. There is a rope manufactory at Manilla, worked by steam, which furnishes a large quantity of ropes, &c., for maritime purposes. Cordage made from this substance does not shrink from damp; but this advantage is counter-balanced by several disadvantages, in consequence of which the abaca cordage is much inferior to that manufactured from hemp; for instance, the former is never so flexible nor so strong as the latter.

The abaca fabrics are a kind of transparent cloth, somewhat stiff, light, and very cool to the touch, from which the *Tugals* make colored shirts. These fabrics are generally striped, and often printed; they might be used with advantage for sifting and straining purposes. Abaca thread does not require to be spun; it is used as produced by nature, and simply joined together end to end. The threads are tied together in bundles, and beaten, for the purpose of softening them, and afterwards bleached by immersion, during twenty-four hours, in lime-water, and dried in the sun; they are then in a fit state for weaving.

A fabric, known under the name of *medriniac*, is also manufactured from unbleached abaca thread, which may be advantageously used for linings of clothes, &c.: this fabric is extensively used for these purposes in Spain.

From the finest abaca thread a pretty stuff, called *jusi*, (houssi,) striped with various colored silks, is manufactured. It is sold at the rate of two piastres every twenty tares, or about six-pence per yard.

Pina is a thread obtained from the leaf of the ananas or pine-apple; it is prepared in the same manner as abaca thread, great care being observed in picking or sorting before uniting them. This thread may be dyed.

Nipis, or vegetable silk, is a filament produced from the leaf of the *nipis* palm tree. A species of pina, of inferior quality, is made from this fibre.

The stuff known at Manilla by the name of *sinamaye* is manufactured from pina and silk, forming stripes of various sizes and colors. Ladies dresses are made from it, and also fine shirts and stomachers.

III. *On the Manufacture of enamelled copper, at Canton.*—When the copper has been shaped into the desired form, it is to be cleaned, but not scoured, and afterwards wetted with water, and sprinkled with the enamelling composition intended to form the ground, which may be either white or colored: the article is then put into a muffle heated by means of dry Nankin coal (this is found to be the best fuel.) When the ground has been produced, the article is withdrawn from the muffle and covered with an iron bell, in order that it may cool slowly: the ground may be then ornamented in the same manner as porcelain, and again passed through the muffle.

Several specimens of enamel, and colors upon enamel, have been deposited by me at the royal manufactory at Sevres, in order that the manufacturers in this kingdom may be made acquainted with the art.

IV. *Method of preserving eggs in China.*—It is customary in China to salt eggs, and by this means to preserve them for several years; the method of doing this is very simple:—A saturated solution of sea-salt is made, and the eggs are placed therein and suffered to remain until they sink to the bottom; they will then be sufficiently impregnated with salt, and may be taken out, left to dry, and packed in cases. These eggs, which are generally eaten boiled hard, are excellent, and they will be found to be salted to the degree most agreeable to the palate.—*Translated from the "Bulletin de la Société d' Encourag.*

Lon. Jour. Arts & Sci.

Production of Coal in the Different States of Europe.

After iron, there is certainly no produce in the mineral kingdom which exercises a greater influence on our commercial relations than coal.

The following is a statistical sketch of the produce of that article in the different countries of Europe.

England possesses the richest veins of coal, both as regards quality and quantity; they form a line from south-west to north-east. In Northumberland and Durham, from the Tweed to the Tees, coal abounds; at Whitehaven, in the hills of Cumberland, in Yorkshire, and in Lancashire. The most abundant mines are in Wales.

The consumption of coal in England and in exportation, is so great, that it has often been asked, if the mines would not be exhausted; but, according to calculations made in proportion to the present con-

sumption, they could not be exhausted under 1500 years—the yearly consumption in Great Britain is 20,000,000 to 21,000,000 of tons.

The exportation increased in the following proportions:—In 1830, 505,421 tons; in 1832, 588,450 tons; in 1834, 621,256 tons; in 1836, 1,101,000 tons; in 1838, 1,413,800 tons; in 1840, 1,621,300 tons; in 1842, 2,120,000 tons; and in 1844, 2,410,000 tons.

The number of miners exceeds 500,000.

English coal is to be had in every part of the civilized world; there are deposits at Rio Janeiro, at Odessa, at Archangel, and at Constantinople.

France does not produce enough coal for her own consumption, and is obliged to import. She possesses 250 mines, of which 182 are worked, and which rendered in 1844, 72,000,000 cwts. of coal to the value of 21,000,000 fr. (£840,000.) The produce is increasing, as in 1815 they only rendered 17,000,000 cwts.; 40,000 men are employed in the mines, and traffic belonging to them. In 1842, the importation of coal into France, amounted to 16,718,328 cwts.

France imports her coal from Belgium, England, and the Prussian provinces on the Rhine.

Spain draws but slight profit from her abundant mines; the principal mine is in the Sierra Morena, the produce is not known. They import but little. In some of the principal Spanish ports, there are depots of English coal for the steamers.

In Portugal there are depots at Figueres, at Coimbra, and near Oporto.

The principal mines of Italy, which produce annually from 140 to 150,000 cwts. are in the Savoy, and near Genoa. The others, scattered over the Peninsula, are of little value, and there are depots of English coal in the principal ports.

Belgium possesses immense mineral riches; in this country production increases. In 1831 the produce amounted to 42,800,000 cwts., and in 1844 it reached 84,232,420. In 1844 the exportation amounted to 1,050,000 tons, a value of about 6,000,000 florins (£600,000.)

Holland has no coal mines. There is a single mine in the country of Limberg. They import all their coal from England, Belgium, and the Prussian provinces.

Switzerland, though rich in metals, has very little coal, and imports a quantity from England. The only mine of any value in this country is at Hochefeld; in 1843, it produced 514,969 cwts.

Norway has no coal mines. In Russia the production of coal does not exceed 800,000 pounds. It seems that between the Don and the Dnieper, and in Siberia, there are rich coal mines, and the Government are now taking measures to turn them to account.

Denmark has one insignificant mine at Bornholm, and imports nearly all her coal from England.

Austria is rich in coal mines, but the produce is not in proportion with the number of her mines. The annual produce of coal in Austria is at least 12,000,000 cwts.: in 1843 it did not exceed 9,000,000. Of this amount Bohemia produces about one-half, Moravia, 2,000,000; Austria, 1,300,000; Styria, 1,000,000; Carinthia and the districts

of Ogragno, a little more than 500,000; Hungary, 600,000; the coast lands (Kusten-land), 60,000; Galicia, 3,000; Lombardy, a very small quantity.

Coal mines exist in nearly every province of the monarchy. In Bohemia there are veins of this mineral along the river Beraun, in the north of the districts of Klattan, Pisen, and Rakovitz, to the neighborhood of Prague. There are coal mines in the Erzgebirge, in the valleys of the Eger and the Biela, and at the foot of the Riesengeberg, from Schatzlar to Landskron.

The principal mines of Moravia are in the district of Brunr, near Rossitz and Oflovan, and the coal near the mouth of the Oder is of a superior quality. In the Archduchy there are mines near Wiener, Neustadt, Klingenfurt, Gübach, and Gloggnitz; in Styria, near Leoben, and Fohnsdorf; in Carinthia, in the valley of the Lavan, and in the neighborhood of Prevali; in Dalmatia; in Lombardy, in the districts of Como and Pavia; in Tyrol, near Haring, and in Hungary, in the Carpathian Mountains.

In 1844, Austria exported 773,065 cwts., of which 703,262 cwts. were sent from Bohemia by the Elbe to Saxony, 25,433 cwts. to Turkey, 23,210 cwts. to southern Germany, and 20,542 cwts. to Prussia.

Prussia possesses 540 coal mines, giving employment to 25,000 workmen. The produce in 1844 amounted to 53,000,000 cwts., or a value of 4,500,000 dollars (£675,000.) In 1841, Prussia imported 3,864,944 cwts. principally from England. Her exportation was 6,903,473 to Holland, France, and Poland.

In Bavaria, the produce is not what it might be; there are 40 extensive coal mines, principally in her Rhenish provinces, the produce is about 1,200,000 cwts.

In Saxony, the mines are worked with zeal, the produce amounts to about 4,000,000 cwts.

There are extensive mines near the forest of Thüringen.

The Grand Duchy of Baden possesses some valuable coal mines.

In the Duchy of Brunswick there is scarcely a mine.

In the kingdom of Hanover there are coal mines which occupy more than 1,000 workmen.

Wurtemberg is poor in this respect. The Grand Duchy of Hesse, the Duchy of Nassau, the Grand Duchies of Meckleburg and Olemburg do not possess coal mines. In the Electorate of Hesse there are some valuable mines, producing annually about 900,000 cwts.

Generally speaking, the production of coal in Europe is susceptible of being greatly developed, especially in some parts of the Austrian dominions. It is true, that during the last few years, much has been done, but there is still much more to do.

The produce of coal in Europe amounts annually, on a rough calculation, to 120,000,000 fl., or £12,000,000. Min.Jour.

Improvement in Smiths' Water Tue-Irons. By W. Noton.

The smiths' water tue-iron as fitted up on the ordinary construction, is bad in principle, lasts a very short time before it is destroyed,

and is eminently calculated for being an expensive item in the economy of the smith's workshop. Much inconvenience and hindrance results from the frequent stoppage occasioned by the failure of this useful appendage to the smithy fire.

My attention was directed to the circumstance, eight or nine years ago, with the intention of finding a remedy for, or at least an amelioration of the evil.

Upon examination of the disabled tue-iron I found the inside, more especially the end nearest the fire, generally filled up with a substance sufficiently solid to prevent any water getting to that part; the place where it is most required to carry away undue temperature; thus the tue-iron is not fairly worn, but burnt out before its time.

What is meant by the ordinary construction may be understood by reference to figs. 1 and 2 of the prefixed sketch:—

Fig. 1.

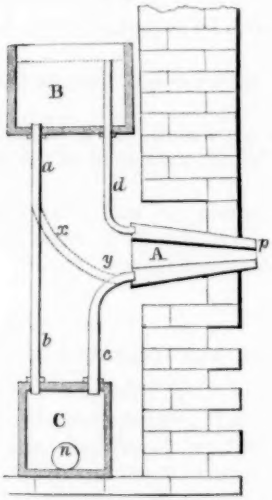
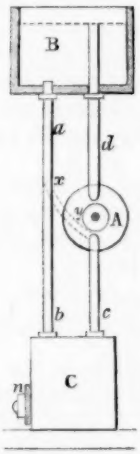


Fig. 2.



A, Water tue-iron.

B, Cistern for water, at a convenient height above A.

a x y, Wrought iron pipe, connecting the lower part of the cistern, B, with the lower part of the tue-iron, A.

d, Another pipe, connected with the upper part of A, and passing either through the bottom of the cistern, B, or by one side, and over the top with a bend.

Water poured into B will descend by the pipe, *a x y*, into the tue-iron, A, driving the air before it up the pipe, *d*, and if sufficient water be supplied till it stands at the height shown by the line in the cistern, the whole of the pipes and tue-iron will be full of water.

In actual working, the nose, P, is covered with burning coal; the water soon attains a boiling temperature, and steam being formed, a portion of the water is driven out of the tue-iron up the pipe, *d*, into